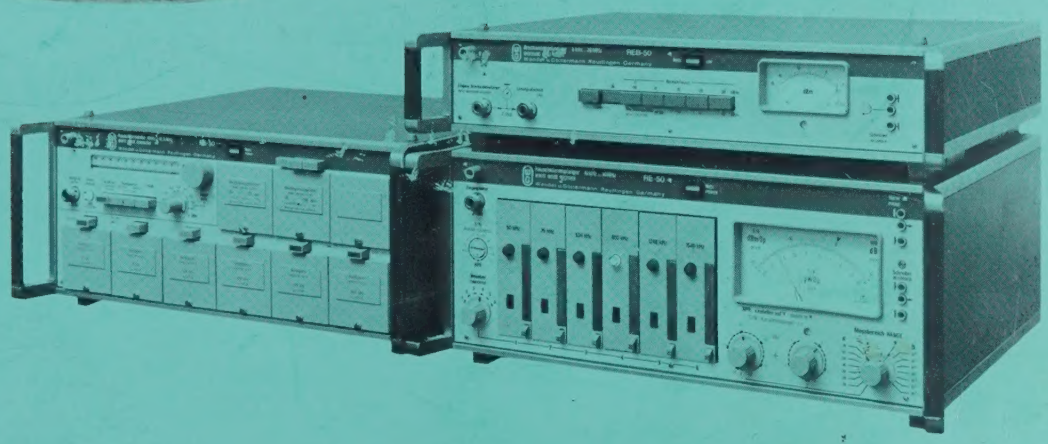
Description and
Operating Manual



MP MASTER
MA33498

White Noise Measuring Set

RK-50

measures the noise power , the S/N (signal-to-noise ratio)
and the NPR (noise power ratio) on frequency division
multiplex cable, radio-link and satellite systems

QUALITY ASSURANCE
STANDARDS, CALIBRATION, AND
MAINTENANCE LAB.

WHITE NOISE MEASURING SET RK-50

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Preliminary description
and operating manual 642/643 A...

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INTRODUCTION

Frequency division multiplex transmission systems (cable, radio-link or satellite systems) are degraded by two types of noise : Intrinsic noise introduced by the circuit elements in the transmission path and intermodulation noise which varies with signal drive and is caused by non-linearities in the system. The total level of noise permitted is defined in the recommendations of the CCIR/CCITT. For measurement and evaluation of the noise there has been increasing use of band-limited noise measuring methods, especially for in service measurements.

Due to its ease of operation and its advantageous dimensions the White Noise Measuring Set RK-50 is particularly suitable for use as a service measuring set for CF systems with up to 2700 telephone channels.

The operational loading of a transmission system can be simulated by means of white noise with a suitable bandwidth. Such a signal is generated by the White Noise Generator RS-50 with a constant noise power density in the frequency range 6 kHz to 12.5 MHz and is limited to the required bandwidth by means of Band-Limiting Filters RSB. One or more Bandstop Filters RSS, connected after the noise source, blank out narrow slots in the noise spectrum which become partially filled with noise during the cause of signal transmission.

The White Noise Receiver RE-50 measures the noise power present in the slots (measuring channels) at the output of the CF system selectively and weights them psophometrically. The necessary selection is carried out in an intermediate frequency filter after conversion with the low-noise Converter Plug-ins REU, which are insensitive to overdriving.

The sensitivity of the noise receiver can be adjusted on the basis of the "transmission level" at the measuring point being used in the system in such a manner, that it indicates the available noise power at an imaginary standard connection with the transmission level Zero. This level, which is indicated with the pW0p-scale, is called the relative noise in order to prevent confusion with the absolute noise power, which can also be interesting for measurements on assemblies. For a system, the relative noise or its level represent a direct indication of the quality of a measuring channel.

The basic behaviour of assemblies and transmission paths of the system can be represented by the relationship of the noise power ratio NPR at various loads and in various measuring channels. The noise power ratio is the difference of the level of the noise power density in a blocked measuring channel compared with a measuring channel which is not blocked. If the same channel is used for measuring both values then the corresponding bandstop filter is switched in and out of the circuit.

The measurements described above can be carried out within the baseband provided for the transmission of telephone conversations or outside this band. If, however, the system is in operation then in-band measurements are generally not acceptable as some of the transmission channels would have to be excluded from the data transfer. For this reason the out-of-band measurement method is used.

For this, suitable bandstop filters suppress any noise which may already be present in one channel above and one channel below the baseband at the input to the path to be tested. At the output the Receiver RE-50, which is set-up for low reflection measurements, measures the noise power present in the slots in the manner described above.

Relationships between the large changes of load during the course of the day and the noise in the out-of-band channel are easily recognized if the total loading is measured with the Wideband Level Meter REB-50 and recorded, together with the noise in the measuring channel, by means of a paper tape recorder with two separate tracks.

All plug-ins of the Measuring Set RK-50 - band-limiting filters, bandstop filters, and converter plug-ins - are easily exchanged, so that the measuring set can be rapidly and easily adapted to the current measuring tasks. The noise bands and measuring frequencies used correspond to the recommendations of CCITT/CIRR and INTELSAT. Other filters for special purposes, some of which are not shown in the literature, are also available.

The high stop-band attenuation of the bandstop filters (as a rule 80 dB in the centre of the band $f_m \pm 1.5$ kHz) and the low intrinsic noise of the Noise Receiver RE-50 allow the measurement of the smallest noises down as far as 3 pW0p (corresponds to -85 dBm0) even at small transmission levels.

Important settings on the measuring set can be controlled by programme. Together with a control unit (e.g. PRA-30) a noise level meter (e.g. PMD-1) and a printer certain measuring sequencies can thus be automatically controlled and recorded.

1. SPECIFICATIONS

All essential characteristics of our instruments are indicated by guaranteed tolerance and limit specifications and not as typical values. They are valid for each instrument not only on delivery but also for the whole guarantee period.

1. TECHNICAL SPECIFICATIONS

1.1. General specifications of the complete measuring set

1.1.1. Ambient temperature

Storage and transport	– 40 to + 70 °C
Rated operating range (see also section 1.2.)	+ 5 to + 40 °C
Limits of operating range	+ 5 to + 40 °C

1.1.2. Mains supply

Possible settings of mains voltage selector . . . 110/117/127/220/227/235 V

Power consumption

White Noise Generator RS-50	approx. 60 W
White Noise Receiver RE-50 with 6 REU	approx. 30 W
Wideband Level Meter REB-50	approx. 20 W

Protection class in accordance with VDE 0411 1

1.1.3. Dimensions, w x h x d in mm

Bench mounting model (overall dimensions)

White Noise Generator RS-50	478 x 199 x 407
White Noise Receiver RE-50.	478 x 199 x 407
Wideband Level Meter REB-50	478 x 110 x 407

Installation dimensions for 19" racks

White Noise Generator RS-50	443 x 176 x 353
White Noise Receiver RE-50	443 x 176 x 353
Wideband Level Meter REB-50	443 x 87 x 353

1.1.4. Weights

White Noise Generator RS-50 (without plug-ins)	12 kg
White Noise Receiver RE-50 (without plug-ins)	12 kg
Wideband Level Meter REB-50	7.5 kg
Band-Limiting Filters RSB	approx. 0.5 kg
Bandstop Filters RSS	approx. 0.5 kg
Converter Plug-ins REU	approx. 0.9 kg

1.1.5. Types of connectors

Coaxial, 75 Ω	Universal connector Versacon® 9
Adapters available for universal connector	all common connector systems (1.6/5.6; 2.5/6; BNC etc.)

1.1.6. Ordering information

White Noise Generator RS-50	BN 642
White Noise Receiver RE-50	BN 643
Wideband Level Meter REB-50	BN 405/1
Band-Limiting Filters RSB	see table 1-2
Bandstop Filters RSS	see tables 1-3 and 1-4
Converter Plug-ins REU	see table 1-7
Bandstop Filter Adapter RSSA-50	BN 674
Matching Transformer 150 Ω symm./75 Ω coax.	BN 419/20
Decoupling Transformer REÜ-4	
Input with 3 soldering terminals.	BN 464/1
Input with 3-pole CF socket.	BN 464/2
Test Probe TK-9	BN 265/0
Control cable (for controlling the RS-50 from the RE-50)	K 176

1.2. Rated operating conditions

The rated operating conditions (ROC) are those operating conditions for any combinations of which the accuracy specified in the following sections is valid.

Any limitations with respect to the rated operating conditions in the specifications for accuracy are specially noted.

Common ROC for RS-50, RE-50 and REB-50	
Mains voltage	110/117/128/220/227/238 V -15% to+10%
Mains frequency	45 to 66 Hz
Ambient temperature	+ 5 to + 40 °C
Warming up period, starting with a cabinet temperature of + 5 to + 40 °C	20 min.
Additional ROC for RS-50	
Use of the Band-Limiting Filters RSB	from table 1-2
Use of the Bandstop Filters RSS	in accordance with table 1-5
Output level	-50 to + 15 dBm
Output load	75 Ω
Additional ROC for RE-50	
Use of the Converter Plug-ins REU	from table 1-7 in accordance with table 1-5
Transmission level (S/N)	-8 to -40 dBr
Channel load level (NPR)	-18 to -50 dBm
Measuring range for S/N mode	from the level of the relative intrinsic noise to 0 dBm0p
Measuring range for NPR mode	from intrinsic NPR to 0 dB
Output impedance of the source	75 Ω
Additional ROC for REB-50	
Frequency range	10 kHz to 20 MHz
Input level	-40 to +11 dBm
Output impedance of the source and termination	75 Ω

Table 1-1 Rated operating conditions

1.3. Measuring modes

1.3.1. S/N mode[1)]

1.3.1.1. Measurement of the relative noise P_N^* in a speech channel of a CF system, i.e. reception of the absolute noise P_N at a point of the system with the transmission level p_C and display of the value

$$P_N^* = P_N \times 10^{-p_C/10}$$

1.3.1.2. Measurement of the power level corresponding to P_N^*

$$p_N^* = p_N - p_C \qquad \text{(Level of the relative noise)}$$

with $$p_N = 10 \lg \frac{P_N}{1\ \text{mW}}$$

Then $$S/N = -p_N^* = p_C - p_N \qquad \text{(Signal-to-noise ratio)}$$

1.3.2. NPR mode

with the baseband occupied with white noise

Measurement of the difference of
the level p'_N of the noise power density in a channel blocked on the transmission side and the level p'_Σ of the noise power density in a channel which is not blocked

$$p'_N - p'_\Sigma = -\,NPR$$

as a function of the baseband loading.

This results from the channel load determined in the non-blocked channel

$$p_0 = p'_\Sigma + 10 \lg \frac{\Delta f_R}{1\ \text{kHz}}$$

as follows:

$$p_\Sigma = p_0 + 10 \lg \frac{\Delta f_G}{\Delta f_R}$$

whereby Δf_G is the noise bandwidth of the generator and Δf_R is the reception bandwidth (1.74 kHz).

1) S/N (signal-to-noise ratio) is the abbreviation for the difference between the noise level in a measuring channel and the level of a test tone (transmission level) whose power is equal to 1 mW recalculated with reference to the zero transmission level point.

1.4. Signal weighting

The receiver indicates white noise in the 3.1 kHz wide speech channel with correct psophometric weighting. The indication is thus equivalent to that of an r.m.s. indication with a bandwidth of 1.74 kHz (equivalent noise bandwidth).

1.5. Intrinsic noise

The intrinsic noise values shown in section 1.5.1. and 1.5.2. result from the finite stop-band attenuation, non-linear distortions of the bandstops, the thermal noise of the receiver, and non-linear distortions of the receiver, when RSS and REU are used in accordance with table 1-5

The output level of the Generator RS-50 should be

for single bandstops $\leqq 0$ dBm
and for multiple combinations $\leqq 0$ dBm $- \Sigma a_G$

(a_G = passband insertion loss of the single bandstops)

Exception: When the Bandstops RSS-5340 (BN 728/50), RSS-7600 (BN 732/50), and RSS-11700 (BN 736/50) are used, the limit of the permissible output level for low noise operation is $\leqq -10$ dBm.

1.5.1. Relative intrinsic noise . . . . . $\leqq 3$ pW0p

Level of the relative intrinsic noise . . . . . $\leqq -85$ dBm0p

The values are valid for transmission levels $p_C \geqq -40$ dBr (with the transmission level fine adjustment 0 to - 2 dB) and for systems with < 240 channels up to a baseband loading of approx. 5 dB above the conventional load or

for systems with $\geqq 240$ channels up to a baseband loading of approx. 10 dB above the conventional load.

1.5.2. Intrinsic NPR [1] . . . . . $\geqq 75$ dB

The value is valid after reference calibration with a channel load $p_0 \geqq -50$ dBm. [2]

1.6. Internal control functions

The receiver controls the generator via a cable.

1.6.1. Separate bandstop selection

When the measuring frequency is selected at the receiver the corresponding plug-in position for bandstops in the generator is selected.

1) See Table 1-5 for the few exceptions

2) This condition is satisfied, when the set-in reference level is $p_C \geqq -40$ dBr after the alignment. However, the fine setting control should be in range 0 to - 2 dB.

1.6.2. Switching out the bandstop

In the position "reference calibration" on the receiver the selected bandstop in the generator is switched out.

1.7. Operating characteristics of the White Noise Generator RS-50

1.7.1. Output signal . . . . . White noise

1.7.1.1. Frequency range . . . . . .6 kHz to 12.5 MHz

1.7.1.2. Amplitude distribution [1] of the noise voltage v(t) with the r.m.s. value v_{rms}:

Normal distribution within range . . . . . $-4 \leqq \frac{v(t)}{v_{rms}} \leqq +4$

1.7.2. Noise band

selectable with exchangeable Band-Limiting Filters RSB . . . . . Table 1-2

3 plug-in positions for RSB, changeover with push buttons

1.7.3. Variation of noise power density with frequency, with bandstop filters switched out

1.7.3.1. Variation with frequency in "flat range"

when the lower band limit $f_u \geqq 12$ kHz. . . . . ± 0.6 dB
when the lower band limit $f_u = 6$ kHz. . . . . ± 1 dB

Limits of the flat range $f_{u,F}$, $f_{o,F}$ . . . . . Table 1-2

1.7.3.2. Effective band limits f_u and f_o . . . . . Table 1-2
Effective bandwidth $f_u - f_o$ . . . . . Table 1-2

1.7.3.3. Decrease of the noise power density outside the effective band limits f_u, f_o, referred to the flat range

where $f \leqq 0.8\ f_u$ and $f \geqq 1.2\ f_o$ . . . . . ≧ 25 dB
where $f \geqq 1.1\ f_o$ . . . . . ≧ 20 dB

Exception for $f_u = 12$ kHz:
Decrease at $f \leqq 9$ kHz . . . . . ≧ 25 dB

1.7.4. Stop-band slots

selectable with exchangeable bandstop Filters RSS . . . Tables 1-3, 1-4, 1-5

6 plug-in positions for RSS

Selection and combination of the inserted bandstops with push buttons

1.7.4.1. Bandstops for use within the noise bands . . . . . Tables 1-3, 1-5

Attenuation caused by power loss due to stop-band slot (automatically compensated) . . . . . .Table 1-6

---

1) For verifying the range of normal distribution (signal with uniform continuous spectrum), the circuit following the band-limiting filter is to be checked with a sinusoidal signal.

The overload point is defined by the peak value of the unlimited voltage at which the fundamental test tone signal is clipped by 10 %.

1.7.4.2. Bandstops for use outside the noise bands . . . . . Table 1-4, 1-5

1.7.5. Output level

1.7.5.1. Setting range

in 1 dB steps, normal. . . . . - 50 to + 5 dBm
increased by 10 dB [1] . . . . . - 40 to - 15 dBm

Fine adjustment in 0.1 dB steps . . . . . 0 to - 1 dB

See section 1.5. for limitations of the output level range in order to attain sufficiently small intrinsic noise.

1.7.5.2. Accuracy of the output level . . . . . ± 0.5 dB

± 10 % of the value selected with the fine adjustment switch

1.7.5.3. Output blocking

Level reduction by . . . . . ≧ 40 dB

1.7.6. Reflection at output [2]

Reflection coefficient for a wave applied to the output from an external source, in the frequency range 6 kHz to 12.5 MHz with bandstop filters switched out . . . . . ≦ 0.05

1.7.7. Digital control

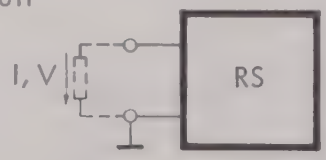
1.7.7.1. Control functions

Switching of the various bandstop filters independently
Selection of one of three noise bands
Adjustment of the output level in 1 dB steps (-50 to +5 dBm)
Blocking the output signal
Switching out the bandstop filters for manual selection

1.7.7.2. Control inputs

Binary 0

Input open circuit

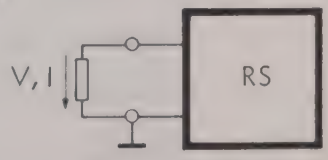


Requirement: I < 0.2 mA

where V < 15 V

Binary 1

Input grounded



Requirement: V < 2 V

where I < 3 mA

1) With a rise of 10 dB, in order that para. 1.7.1.2. remains valid, the sum of the insertion losses of the switched-in bandstop filters should not exceed 2 dB within the selected noise band.

2) When verifying the value of reflection coefficient, measurement error due to automatic level control can be prevented if the reflection is measured with a measurement bridge while the noise generator is blanked out.

1.8. Operating characteristics of the White Noise Receiver RE-50

1.8.1. Frequency range . . . . . 10 kHz to 14 MHz

1.8.1.1. Measuring frequencies

selectable with exchangeable Converter Plug-ins REU . . . . . .Table 1-7

Changeover with rotary switch

1.8.1.2. Selectivity

See Fig. 1-2 and 1-3 for typical selectivity characteristics

Equivalent noise bandwidth (see also section 1.4.) . . . . . 1.74 kHz

1.8.2. Measuring range

1.8.2.1. Indication range

for S/N mode: relative noise . . . . . 1 to 10^9 pW0p
level of the relative noise . . . . . .- 90 to 0 dBm0p

for NPR mode: . . . . . .- 90 to 0 dB

1.8.2.2. Instrument scale

Level scale with linear indication . . . . . - 20 to + 10 (dB)
Power scale . . . . . 0.01 to 10 (pW0p)

1.8.2.3. Reference level range [1]

Transmission level (S/N). . . . . - 8 to - 40 (- 60) dBr
Channel load level (NPR) [2] . . . . . .- 18 to - 50 (- 70) dBm

1.8.2.4. Overdrive capability

Relationship of the weighting limit for the input voltage to its r.m.s. value for a meter indication $\leqq$ 0 dB . . . . . $\geqq$ 10

1.8.3. Measuring accuracy

If the measured level is $\leqq$ 20 dB above the intrinsic noise of the receiver, an additional error in accordance with Fig. 1-1 must be taken into account.

1.8.3.1. NPR mode

for meter indication in the range - 5 to + 5 dB. . . . . $\pm$ 0.5 dB

---

1) The reference level partial ranges as shown in brackets are not valid for the rated intrinsic noise specifications indicated in para. 1.5. The relative instrinsic noise of the receiver could increase by the difference - p_C - 40 dB when the transmission level is p_C < - 40 dBr or - p_0 - 50 dB when the channel load level is p_0 < - 50 dBm.

2) The adjusted channel load level is $p_0 = p_C - 10$ dB.

1.8.3.2. S/N mode

after reference calibration

for meter indication in the range - 5 to + 5 dB . . . . . ± 0.55 dB + q

where q is shown as a function of the number of system channels in table 1-8 ($|q| \leqq 0.26$ dB)

1.8.3.3. S/N mode

after setting the nominal value of the transmission level

for meter indication - 5 to + 5 dB . . . . . ± 1.3 dB

1.8.4. Intrinsic noise

for transmission level coarse setting $\leqq$ - 38 dBr . . . . . = - 126 dBm

1.8.5. Input

1.8.5.1. Reflection factor

within a frequency band in accordance with table 1-5 and with measuring frequencies permitted there . . . . . $\leqq 0.1$

1.8.5.2. Largest permissible input level (noise) . . . . . + 17 dBm

1.8.6. Outputs

1.8.6.1. Recorder output

Linear voltage variation with level, open circuit voltage at full scale deflection of the meter, adjustable . . . . . 0 to 200 mV

Output impedance . . . . . approx. 2.4 kΩ

Output loadable up to short circuit

Settling time for rise/fall[1] . . . . . 0.22/3.8 s

1.8.6.2. AF outputs

IF passband characteristics

See Fig. 1-3 for typical values

Frequency band with attenuation < 3 dB . . . . . approx. 350 to 980 Hz

AF output I

Increase of the noise power density compared with the REU input

with open circuit output . . . . . approx. 60 dB

Output impedance . . . . . 4.6 kΩ

1) The response times are valid for the transition from 10 % to 90 % of the output voltage amplitude jump which corresponds to full scale deflection (30 dB).

AF output II

for external S/N evaluation

S/N range for any position of the range switches except -10 dB and ▼ . . . . . -90 to -10 dBm0p

corresponding range of the level 20 lg (v_{rms}: 775 mV) of the open circuit voltage v_{rms} at the output . . . . . -79 to +1 dB

Output impedance . . . . . 1 kΩ

Headphone output

Open circuit voltage v_{rms} for meter indication 0 dB . . . . . approx. 275 mV

Output impedance . . . . . 600 Ω

1.8.7. Digital control

1.8.7.1. Inputs for selection of the measuring frequency

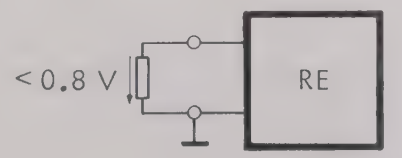
5 V - TTL, load factor 1

1.8.7.2. Input for switching to reference measurement

Reference measurement:

Input grounded

Requirement:

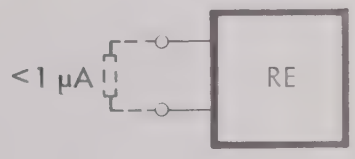


where I < 55 µA

No reference measurement:

Input open circuit

Requirement:



where V < +2 V

1.8.7.3. Control outputs for separate bandstop control and switching out of bandstops

The outputs fulfill the requirements of the corresponding inputs of the RS-50 as shown in section 1.7.7.2.

1.9. Operating characteristics of the Wideband Level Meter REB-50

1.9.1.	Frequency range	6 kHz to 30 MHz
1.9.2.	Level measurement, indication range	- 50 to + 11 dBm
1.9.3.	Result indication	
1.9.3.1.	Meter scale with linear level calibration	- 20 to + 1 dB
1.9.3.2.	Range switching in 10 dB steps, measured values for 0 dB indication	- 30, - 20, - 10, 0, + 10 dBm
1.9.4.	Signal weighting	
1.9.4.1.	Weighting of the input signal with thermal principle	r.m.s.
1.9.4.2.	Overload limit [1]	
	for full-scale deflection of the meter	> 4 v_{rms}
	for meter indication - 7 dB	> 10 v_{rms}
1.9.5.	Accuracy	
	after calibration, taking into account all error possibilities in the rated operating conditions (see section 1.2.), for noise or sine-wave signal, for indication in the scale range - 10 to + 1 dB	± 0.8 dB
1.9.6.	Input	
1.9.6.1.	Insertion loss of the input loop	
	for frequencies < 20 MHz	≦ 0.15 dB
	for frequencies < 30 MHz	≦ 0.25 dB
1.9.6.2.	Reflection factor of the terminated loop	
	in the frequency range 10 kHz to 20 MHz	≦ 0.02
	in the frequency range 6 kHz to 30 MHz	≦ 0.05
1.9.6.3.	Permissible input amplitude	± 5 V

1) The limit of the signal-drive capability is considered to be the peak value of a sinusoidal voltage whose fundamental test tone signal after passing through an amplifier has been clipped by 10 %. Also see foot-note 1 on page 1-7.

1.9.7. Outputs

1.9.7.1. Recorder output

Open circuit voltage for 0 dB meter indication, adjustable . . . . . 0 to 250 mV

Output impedance . . . . . 2.5 kΩ

Output loadable up to short circuit

1.9.7.2. D.C. voltage output with higher voltage

Open circuit voltage for 0 dB meter indication, adjustable . . . . . 0 to 5 V

Output impedance . . . . . < 1 kΩ

Usable current . . . . . 0.2 mA

Short circuit prove

1.9.7.3. D.C. voltage output for current supply of low impedance circuits

Open circuit voltage, adjustable . . . . . 0 to 5 V

Short circuit current . . . . . 0 to 70 µA

1.10. Measuring transformers for special matching conditions

1.10.1. Transformer 150/75 Ω

for matching the measuring set to symmetrical systems with a characteristic impedance of 150 Ω for the frequency range . . . 6 to 600 kHz

Attenuation of the power level

When inserting the transformer between a 150 Ω source and a 75 Ω termination or vice versa . . . . . ≦ 0.2 dB

Reflection at correctly terminated transformer. . . . . ≦ 0.02

1.10.2. Decoupling Transformer REÜ-4

for high impedance connection of the Receivers RE-50 and REB-50 to matched symmetrical lines with a characteristic impedance of 150 Ω

for the frequency range . . . . . 10 to 600 kHz

Input impedance . . . . . approx. 7.5 kΩ ‖ 150 pF

Max. reflection in the line due to connection of the REÜ-4. . . . . ≦ 0.05

Attenuation of the power level when terminated with 75 Ω . . . . 20 ± 0.1 dB

1.10.3. Test Probe TK-9

for high impedance connection of the Receivers RE-50 and REB-50 to matched coaxial lines with a characteristic impedance of 75 Ω,

for the frequency range . . . . . 50 kHz to 15 MHz

Input impedance . . . . . approx. 5 kΩ ‖ 17 pF

Max. reflection in the line due to connection of TK-9 . . . . approx. 0.05

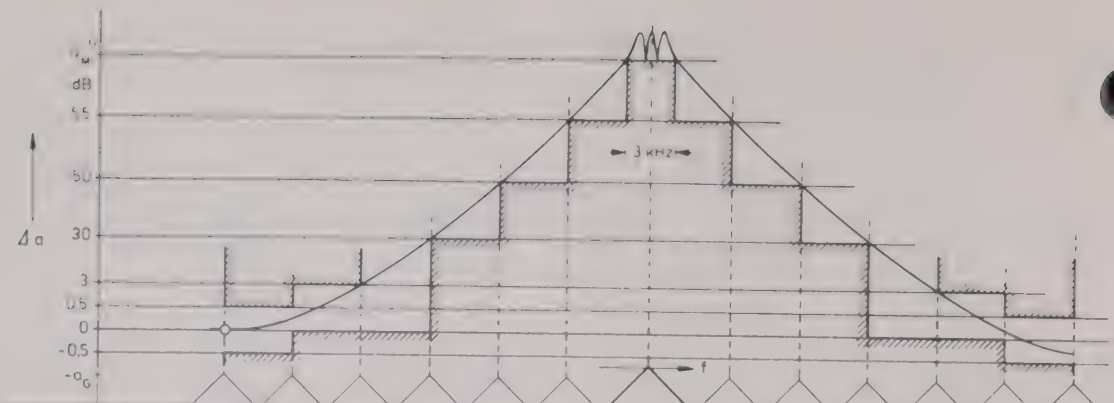
Attenuation, when terminated with 75 Ω

in the frequency range 50 kHz to 13 MHz . . . . . 20 ± 0.1 dB

in the frequency range 13 to 15 MHz . . . . . $20\ ^{+0.1}_{-0.25}$ dB

Type	Order number	Effective band limits		Tolerance for		Eff. band-width kHz	Flat range (see section 1.7.3.1.) kHz
		f_u/kHz	f_o/kHz	Δf_u/kHz	Δf_o/kHz		
RSB-6/54	BN 8530/50	6	54	± 0.1	± 0.4	48	8.5-52
RSB-6/60	BN 8531/50	6	60	± 0.1	± 0.4	54	8.5-58
RSB-6/108	BN 8556/50	6	108	± 0.1	± 0.8	102	8.5-100
RSB-12/60	BN 8546/50	12	60	± 0.2	± 0.4	48	13-58
RSB-12/108	BN 8532/50	12	108	± 0.2	± 0.8	96	13-100
RSB-12/156	BN 8572/50	12	156	± 0.2	± 1	144	16-140
RSB-12/252	BN 8533/50	12	252	± 0.2	± 2	240	13-242
RSB-12/300	BN 8573/50	12	300	± 0.2	± 2	288	13-272
RSB-12/408	BN 3559/50	12	408	± 0.2	± 3	396	13-396
RSB-12/552	BN 8534/50	12	552	± 0.2	± 4	540	13-536
RSB-12/804	BN 8560/50	12	804	± 0.2	± 6	792	13-772
RSB-12/1052	BN 8561/50	12	1052	± 0.2	± 7	1040	13-1004
RSB-12/1296	BN 8574/50	12	1296	± 0.2	± 12	1284	13-1250
RSB-12/1796	BN 8562/50	12	1796	± 0.2	± 12	1784	13-1732
RSB-12/2600	BN 8563/50	12	2600	± 0.2	± 20	2588	13-2440
RSB-12/3284	BN 8564/50	12	3284	± 0.2	± 25	3272	13-3152
RSB-12/4100	BN 8565/50	12	4100	± 0.2	± 30	4088	13-3883
RSB-12/4892	BN 8570/50	12	4892	± 0.2	± 38	4880	13-4650
RSB-12/8160	BN 8558/50	12	8160	± 0.2	± 75	8148	13-7602
RSB-60/108	BN 8547/50	60	108	± 1	± 0.8	48	68-100
RSB-60/300	BN 8535/50	60	300	± 1	± 2	240	68-272
RSB-60/552	BN 8536/50	60	552	± 1	± 4	492	68-536
RSB-60/1052	BN 8549/50	60	1052	± 1	± 7	992	63-1004
RSB-60/1296	BN 8537/50	60	1296	± 1	± 8	1236	68-1250
RSB-60/2600	BN 8538/50	60	2600	± 1	± 20	2540	68-2440
RSB-60/4100	BN 8539/50	60	4100	± 1	± 30	4040	68-3888
RSB-60/5600	BN 8541/50	60	5600	± 1	± 50	5540	68-5342
RSB-316/552	BN 8548/50	316	552	± 5	± 4	236	345-536
RSB-316/4100	BN 8540/50	316	4100	± 5	± 30	3784	532-3888
RSB-316/5600	BN 8542/50	316	5600	± 5	± 50	5284	532-5342
RSB-316/8160	BN 8543/50	316	8160	± 5	± 75	7844	532-7602
RSB-316/12360	BN 8544/50	316	12360	± 5	± 100	12044	532-11702

Table 1-2 Band-Limiting Filters RSB

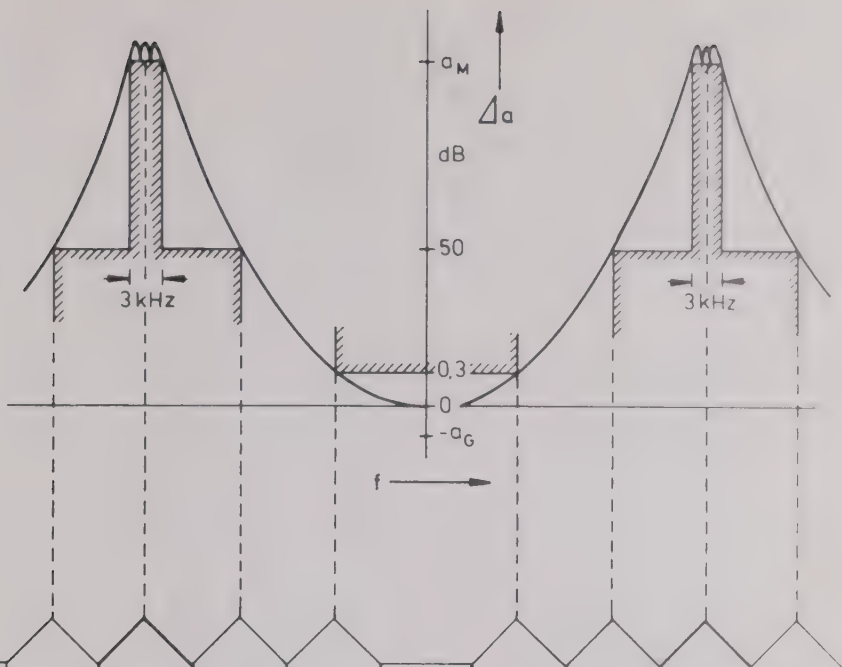


Type	Order number	f_u kHz	f_{5u} kHz	f_{4u} kHz	f_{3u} kHz	f_{2u} kHz	f_{1u} kHz	f_M kHz	f_{1o} kHz	f_{2o} kHz	f_{3o} kHz	f_{4o} kHz	f_{5o} kHz	f_o kHz
RSS-10	BN 701 [2]	6	6.5	6 7	7.25	—	7.45	9.24 (-174/+151)	10.9	—	11.15	11.75	12	552
RSS-16	BN 707/50	6	8	11	13.3	—	13.9	16	18.1	—	18.7	21	24	4100
RSS-50	BN 703/50	6	40	42 5	—	47.75	—	50	—	52.25	—	57 5	60	5600
RSS-57	BN 704/50	6	50	52	54.5	—	55	57	59	—	59.5	62	64	2600
RSS-70	BN 705/50	6	57	58	66.5	—	67.8	70	72.2	—	73.5	82	83	8160
RSS-98	BN 706/50	6	90	94	95.5	—	96	98	100	—	100.5	102	106	5600
RSS-119	BN 708 [2]	6	108	111	—	116.4	—	119	—	121.6	—	127	140	8160
RSS-140	BN 729/50	12	125	135	137.8	—	138.2	140	141,8	—	142.2	145	155	8160
RSS-230	BN 710/50	12	205	218	226	—	227.5	230	232.5	—	234	242	255	8160
RSS-240	BN 709/52	12	220	235	237.5	—	238.1	240	241.9	—	242.5	245	260	8160
RSS-270	BN 711/50	12	251	262	267.1	—	267.7	270	272.3	—	272.9	278	289	5600
RSS-270	BN 711/51	12	220	253	—	266.65	--	270	—	273.35	—	287	316	12360
RSS-331	BN 712/50	12	300	312	—	328	—	331	—	334	—	348	360	8160
RSS-394	BN 713/52	12	344	383	389.3	—	391.1	394	396.2	—	398.7	405	444	8160
RSS-534	BN 714/50	12	498	519	527	—	530.5	534	537.5	—	541	549	570	12360
RSS-600	BN 716/50	12	552	565	—	595	—	600	—	605	—	635	650	8160
RSS-770	BN 717/50	12	670	749	761.3	—	766.2	770	773.8	—	778.7	791	870	12360
RSS-1002	BN 718/50	12	872	973	992	—	998	1002	1006	—	1012	1031	1132	12360
RSS-1248	BN 719/50	12	1178	1208	1237	—	1244	1248	1252	—	1259	1283	1313	12360
RSS-1549	BN 720/50	12	1300	1439	—	1539	—	1549	—	1559	—	1659	1900	12360
RSS-1730	BN 721/50	12	1480	1634	1715.5	—	1725.7	1730	1734.3	—	1744.5	1776	1980	12360
RSS-2433	BN 722/50	12	2258	2373	2419	—	2433.5	2438	2442.5	—	2457	2498	2618	12360
RSS-3150	BN 724/50	12	2800	3065	3126	—	3141	3150	3159	—	3174	3235	3500	12360
RSS-3200	BN 725/50	12	2600	3000	—	3182	—	3200	—	3218	—	3400	3500	12360
RSS-3886	BN 726/50	12	3606	3776	3856	—	3871	3886	3901	—	3916	3996	4166	12360
RSS-3886	BN 726/52	12			—	—	—	3886	—	—	—			12360
RSS-4650	BN 730/50	12	4530	4637	4646.2	—	4648	4650	4652	—	4653.8	4363	4770	12360
RSS-4715	BN 727/50	12	4100	4465	—	4689.4	—	4715	—	4740.6	—	4965	5200	12360
RSS-5340	BN 728/50	60	5040	5326	5336	—	5337.8	5340	5342.2	—	5344	5354	5640	12360
RSS-5340	BN 728/2 [2]	12	5200	5324	5336	—	5337.8	5340	5342.2	—	5344	5354	5480	12360
RSS-6300	BN 731/50	12	5600	5950	—	6266.5	—	6300	—	6333.5	—	6650	7500	12360
RSS-7600	BN 732/50	316	6400	7584	7595.4	—	7597.6	7600	7602.4	—	7604.6	7616	8800	12360
RSS-7600	BN 732/2 [2]	12	7400	7584	7595.4	—	7597.6	7600	7602.4	—	7604.6	7616	7800	12360
RSS-9073	BN 735/50	316	8160	8573	—	9025.5	—	9073	—	9120.5	—	9573	10000	12360
RSS-11700	BN 736/50	316	10700	11630	11693	—	11697	11700	11703	—	11707	11720	12000	12360
RSS-11700	BN 736/2	316	11400	11680	11693	—	11697	11700	11703	—	11707	11720	12000	12360

Table 1-3 Bandstop Filters RSS for use within the noise bands

1) Instead of the value for a_M the intrinsic NPR of the measuring set is specified (see table 1-5).

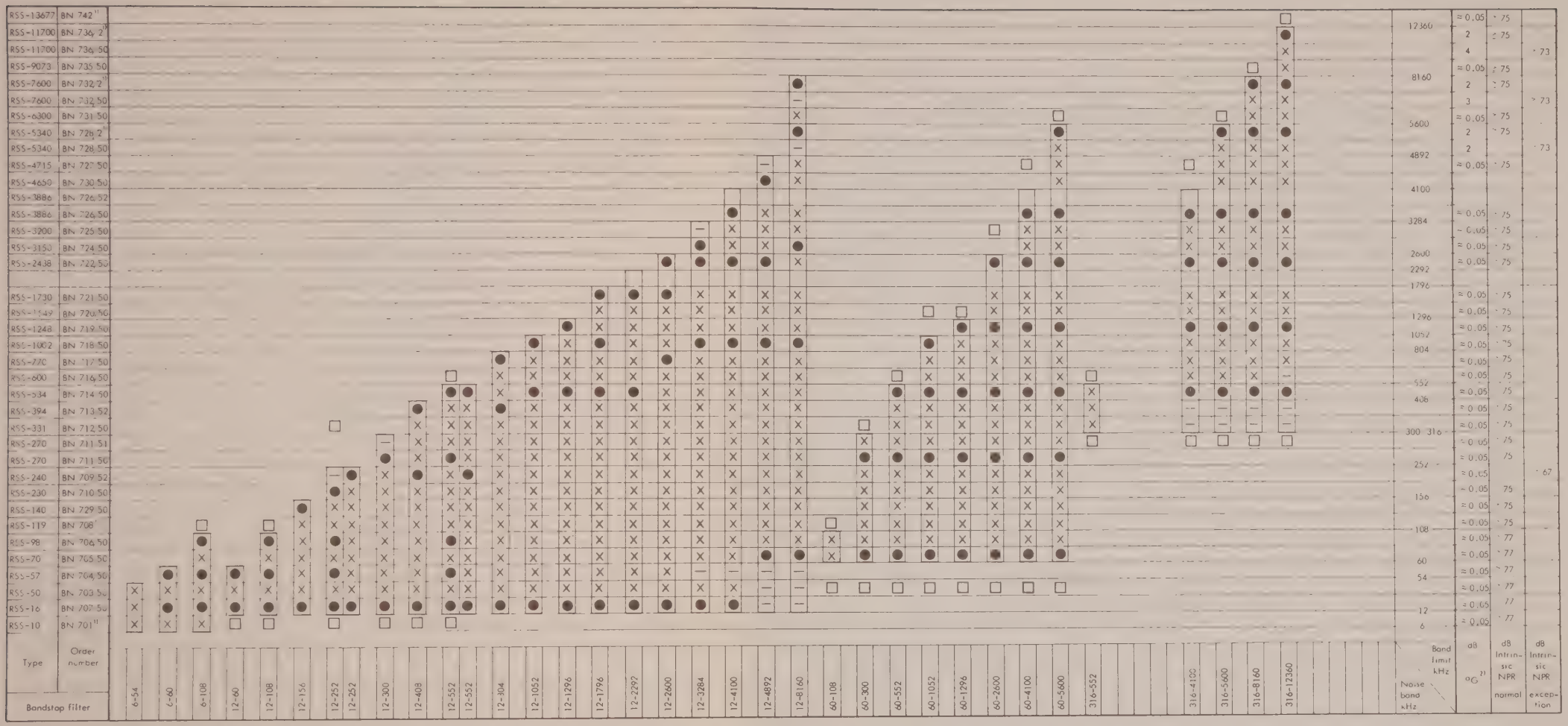
2) Double-width version, connection via Bandstop Filter Adapter RSSA-50.



Type	Order number	$f_{u,u}$ kHz	$f_{u,M}$ kHz	$f_{u,o}$ kHz	f_u kHz		f_o kHz	$f_{o,u}$ kHz	$f_{o,M}$ kHz	$f_{o,o}$ kHz
RSS-10	BN 701 [1]	7.4	9.24	11	12,5	—	552	—	—	—
RSS-50	BN 703/50	47.75	50	52.25	60	—	5600	—	—	—
RSS-119	BN 708 [1]	—	—	—	6	—	108	116.4	119	121.6
RSS-270	BN 711/51	266.65	270	273.35	316	—	12360	—	—	—
RSS-331	BN 712/50	—	—	—	12	—	300	327.34	331	334.66
RSS-600	BN 716/50	—	—	—	12	—	552	595	600	605
RSS-1549	BN 720/50	—	—	—	60	—	1296	1539.25	1549	1558.75
RSS-3200	BN 725/50	—	—	—	60	—	2600	3182	3200	3218
RSS-4715	BN 727/50	—	—	—	60	—	4100	4689.4	4715	4740.6
RSS-6300	BN 731/50	—	—	—	12	—	5600	6266.5	6300	6333.5
RSS-9073	BN 735/50	—	—	—	316	—	8160	9025.5	9073	9120.5
RSS-13677	BN 742 [1]	—	—	—	316	—	12360	13607	13677	13747

Table 1-4 Bandstop Filters RSS for use outside the noise bands

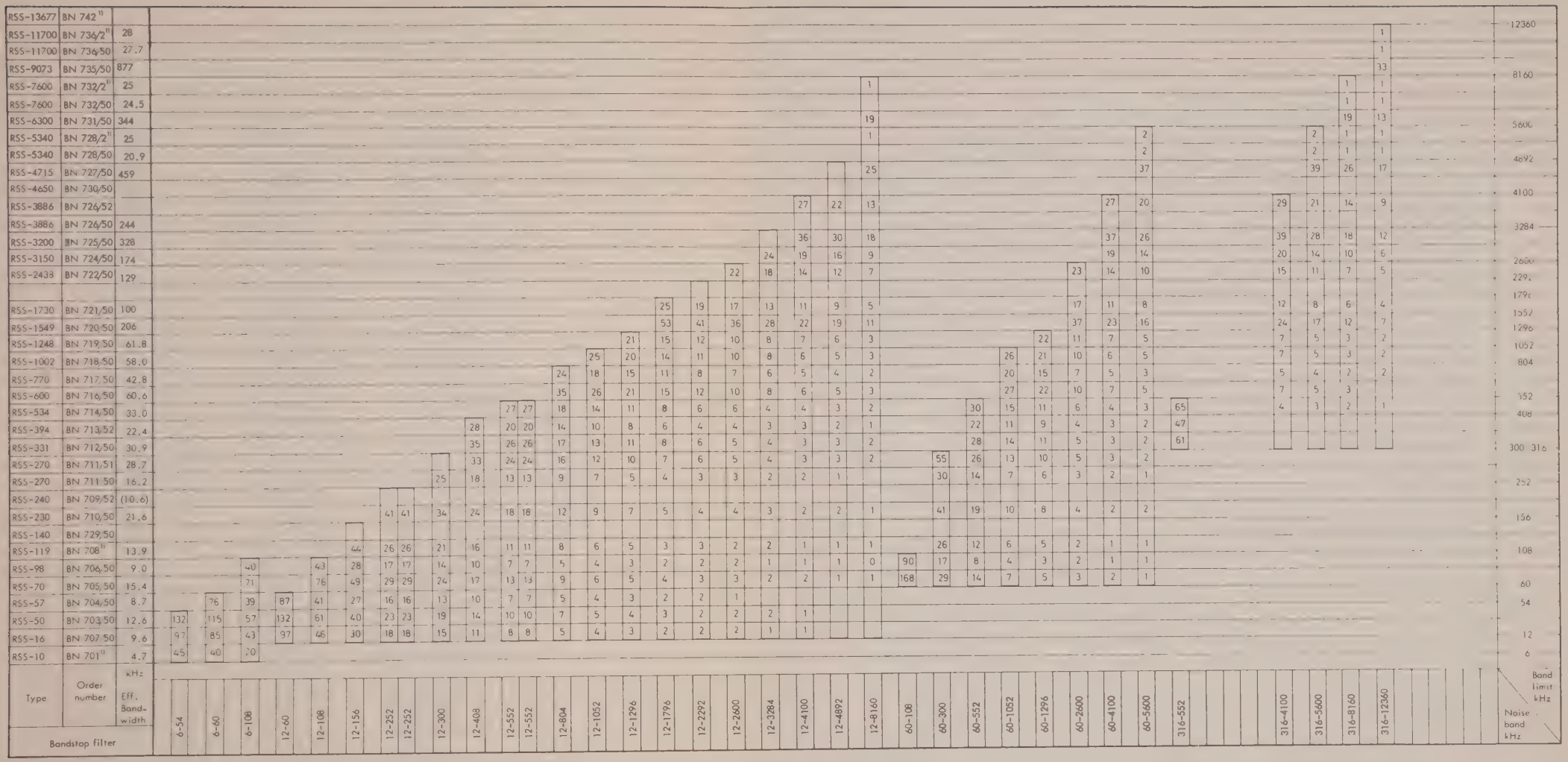
1) Double-width version.



1) Double-width version.

2) Passband insertion loss a_G in accordance with diagram in tables 1-3 and 1-4.

Table 1-5 Recommended uses of bandstop filters



1) Double-width version.

$$a_L = 1000 \log \left(1 - \frac{\text{Effective stop-width}}{\text{Width of the noise band}}\right)$$

(Specified in Millibel)

Table 1-6 Attenuation caused by power loss due to stop-band slot (automatically compensated)

Type	Order number	Range of use kHz
REU-10	BN 402/1	6- 552
REU-16	BN 402/7	6- 4100
REU-50	BN 402/3	6- 5600
REU-57	BN 402/4	6- 4100
REU-70	BN 402/5	6- 8160
REU-98	BN 402/6	6- 5600
REU-119	BN 402/8	6- 8160
REU-140	BN 402/29	12- 8160
REU-230	BN 402/10	12- 8160
REU-240	BN 402/9	12- 8160
REU-270	BN 402/11	12-12360
REU-331	BN 402/12	12- 8160
REU-394	BN 402/13	12- 8160
REU-534	BN 402/14	12-12360
REU-600	BN 402/16	12- 8160
REU-770	BN 402/17	12-12360
REU-1002	BN 402/18	12-12360
REU-1248	BN 402/19	12-12360
REU-1549	BN 402/20	12-12360
REU-1730	BN 402/21	12-12360
REU-2438	BN 402/22	12-12360
REU-3150	BN 402/24	12-12360
REU-3200	BN 402/25	12-12360
REU-3886	BN 402/26	12-12360
REU-4650	BN 402/30	12-12360
REU-4715	BN 402/27	12-12360
REU-4765	BN 402/45	12-12360
REU-5340	BN 402/28	12-12360
REU-6300	BN 402/31	12-12360
REU-7600	BN 402/32	12-12360
REU-9073	BN 402/35	12-12360
REU-11700	BN 402/36	316-12360
REU-13677	BN 402/42	316-13680

Table 1-7 Converter Plug-ins REU

Number of channels n	Noise band kHz	Bandwidth Δf_G kHz	$p^*_{\Sigma,C}$ dBm0	$10 \lg \frac{\Delta f_G}{\Delta f_R}$ dB	Y_N dB	$Y_{N,Ref.}$ dB	q dB
12	6-54	48	3.32	14.41	11.09	11.35	- 0.26
12	6-60	54	3.32	14.92	11.60	11.35	+ 0.25
12	12-60	48	3.32	14.41	11.09	11.35	- 0.26
12	60-108	48	3.32	14.41	11.09	11.35	- 0.26
24	6-108	102	4.52	17.68	13.16	13.05	+ 0.11
24	12-108	96	4.52	17.42	12.90	13.05	- 0.15
36	12-156	144	5.23	19.18	13.95	13.90	+ 0.05
60	12-252	240	6.11	21.40	15.29	15.30	- 0.01
60	60-300	240	6.11	21.40	15.29	15.30	- 0.01
60	316-552	236	6.11	21.32	15.21	15.30	- 0.09
72	12-300	288	6.43	22.19	15.76	15.80	- 0.04
96	12-408	396	6.93	23.57	16.64	16.70	- 0.06
120	60-552	492	7.32	24.51	17.19	17.40	- 0.21
132	12-552	540	7.48	24.92	17.44	17.40	+ 0.04
192	12-804	792	8.13	26.58	18.45	18.50	- 0.05
240	60-1052	992	8.80	27.56	18.76	18.90	- 0.14
252	12-1052	1040	9.01	27.76	18.75	18.90	- 0.15
300	60-1296	1236	9.77	28.51	18.74	18.90	- 0.16
300	308-1552	1244	9.77	28.54	18.77	18.90	- 0.13
300	812-2044	1232	9.77	28.50	18.73	18.90	- 0.17
312	12-1296	1288	9.94	28.69	18.75	18.90	- 0.15
432	12-1796	1784	11.35	30.11	18.76	18.90	- 0.14
552	12-2292	2280	12.42	31.17	18.75	18.90	- 0.15
600	60-2600	2540	12.78	31.64	18.86	18.90	- 0.04
612	12-2600	2588	12.87	31.72	18.85	18.90	- 0.05
792	12-3284	3272	13.99	32.74	18.75	18.90	- 0.15
900	316-4100	3784	14.54	33.37	18.83	18.90	- 0.07
900	4332-8160	3828	14.54	33.42	18.88	18.90	- 0.02
900	8516-12360	3844	14.54	33.44	18.90	18.90	± 0.00
960	60-4100	4040	14.82	33.66	18.84	18.90	- 0.06
972	12-4100	4088	14.88	33.71	18.83	18.90	- 0.07
1092	12-4392	4880	15.38	34.48	19.10	18.90	+ 0.20
1200	316-5600	5284	15.79	34.82	19.03	18.90	+ 0.13
1260	60-5600	5540	16.00	35.03	19.03	18.90	+ 0.13
1800	316-8160	7844	17.55	36.54	18.99	18.90	+ 0.09
1872	12-8160	8148	17.72	36.71	18.99	18.90	+ 0.09
2700	316-12360	12044	19.31	38.40	19.09	18.90	+ 0.19

$p^*_{\Sigma,C} = -1 + 4 \log n$ for $n < 240$

$p^*_{\Sigma,C} = -15 + 10 \log n$ for $n \geq 240$

$q = Y_N - Y_{N,Ref.}$

$f_E = 1.74$ kHz (Equivalent reception bandwidth)

$Y_N = 10 \log \frac{\Delta f_G}{\Delta f_R} - p^*_{\Sigma,C}$

$Y_{N,Ref.}$ is the value taken into account for reference calibration instead of Y_N

Table 1-8 Partial error q for S/N reference calibration

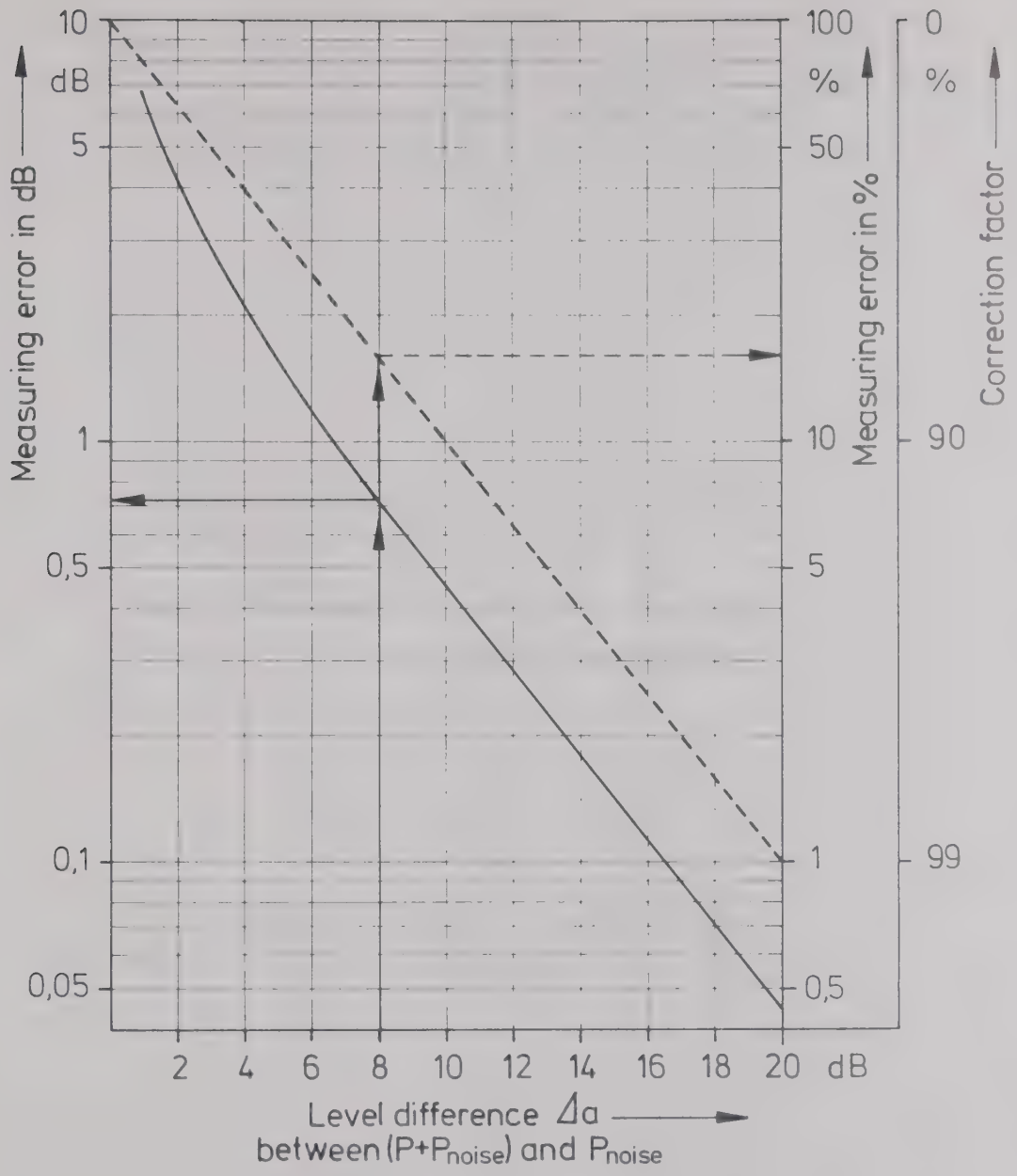


Fig. 1-1 Determination of the measuring error caused by insufficient spacing from the instrinsic noise of the receiver

Example: $P + P_{noise} \mathrel{\hat{=}} -90$ dBm0p
$P_{noise} \mathrel{\hat{=}} -98$ dBm0p
$\Delta a = 8$ dB

From Fig. 1-1: Error is 0.75 dB or 16 %
Corrected result: -90 dBm0p - 0.75 dB = - 90.75 dBm0p
or 1 pW0p x 0.84 = 0.84 pW0p

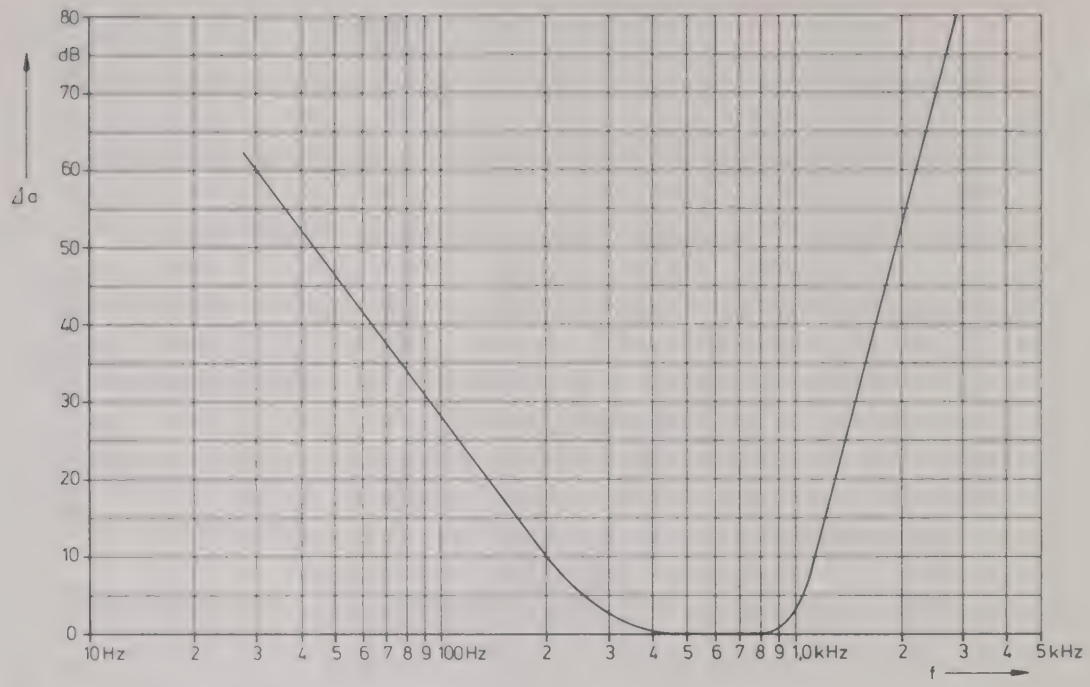


Fig. 1-2 Typical IF bandpass characteristic

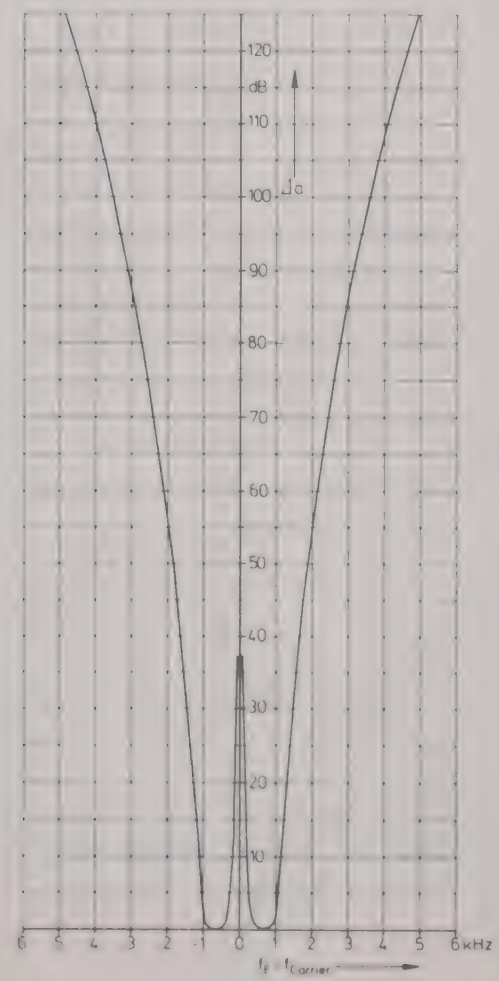


Fig. 1-3 Typical selectivity characteristic

2. OPERATION

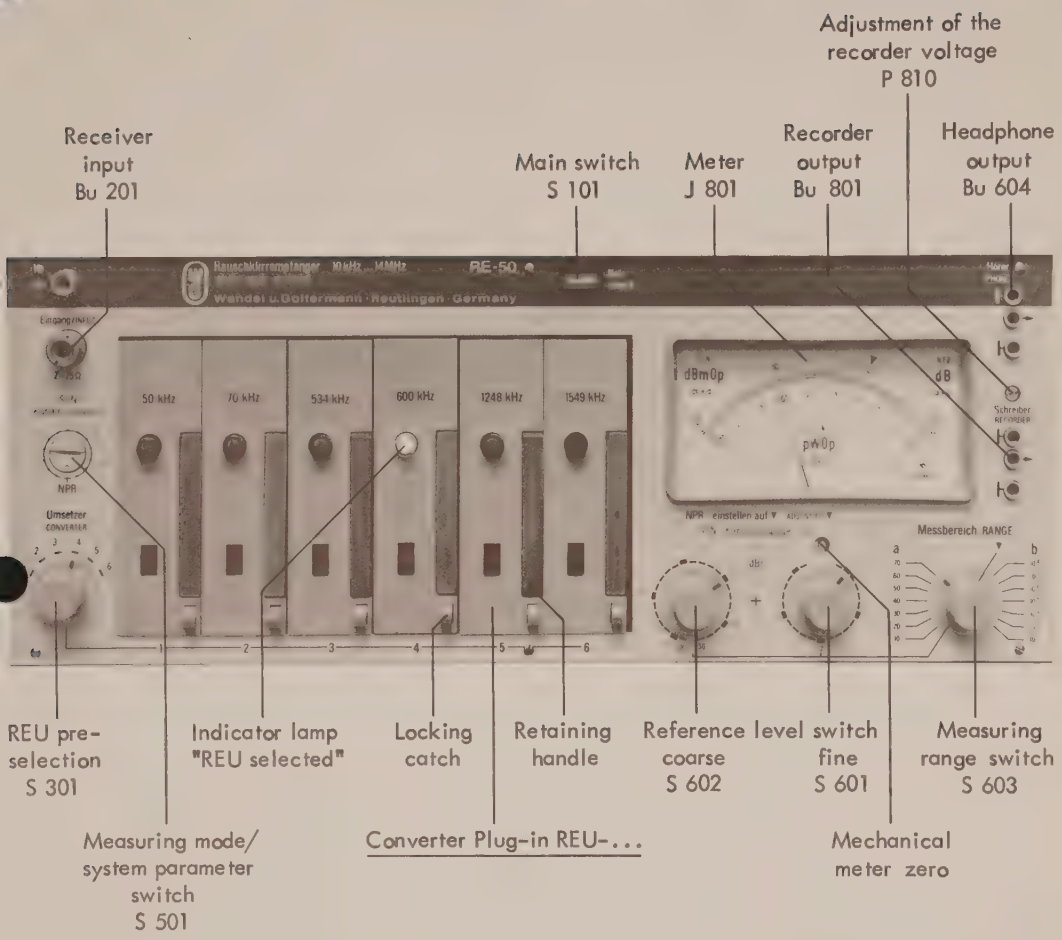

Adjustment of the recorder voltage P 810
Receiver input Bu 201
Main switch S 101
Meter J 801
Recorder output Bu 801
Headphone output Bu 604
REU pre-selection S 301
Indicator lamp "REU selected"
Locking catch
Retaining handle
Reference level coarse S 602
switch fine S 601
Measuring range switch S 603
Measuring mode/ system parameter switch S 501
Converter Plug-in REU-...
Mechanical meter zero

Fig. 2-3 Front view of the White Noise Receiver RE-50

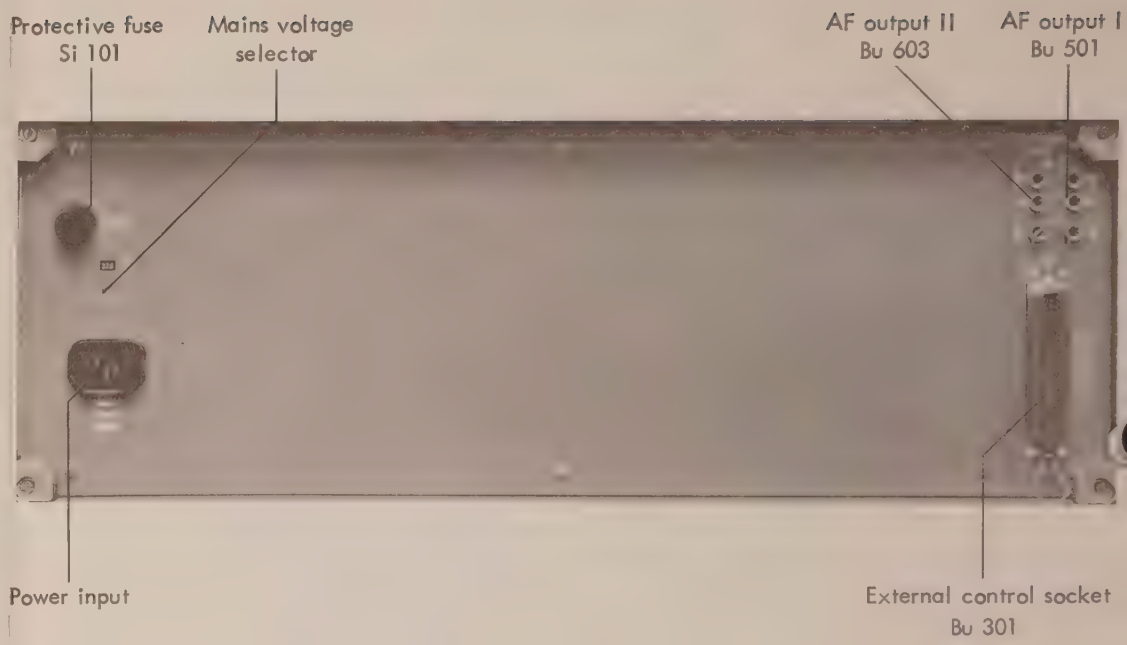

Protective fuse Si 101
Mains voltage selector
AF output II Bu 603
AF output I Bu 501
Power input
External control socket Bu 301

Fig. 2-4 Rear view of the White Noise Receiver RE-50

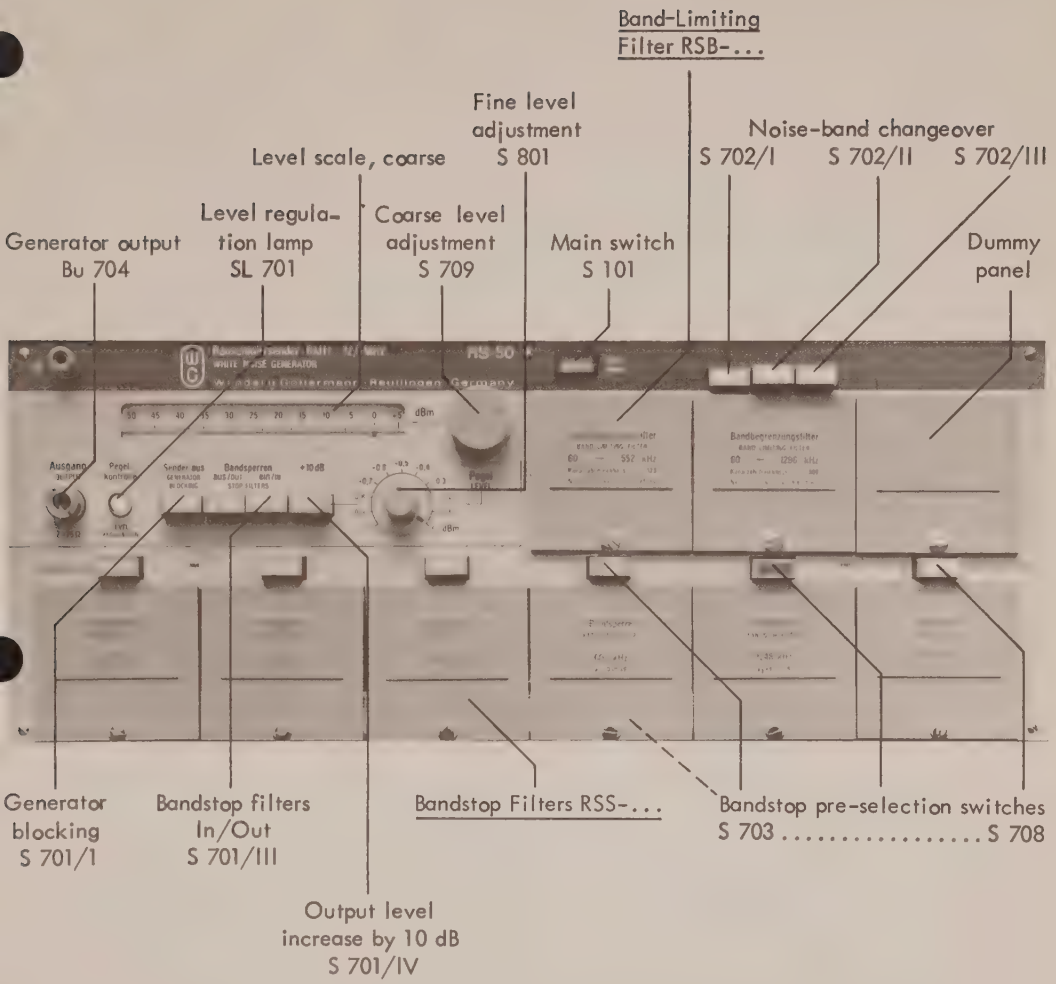


Fig. 2-1 Front view of the White Noise Generator RS-50

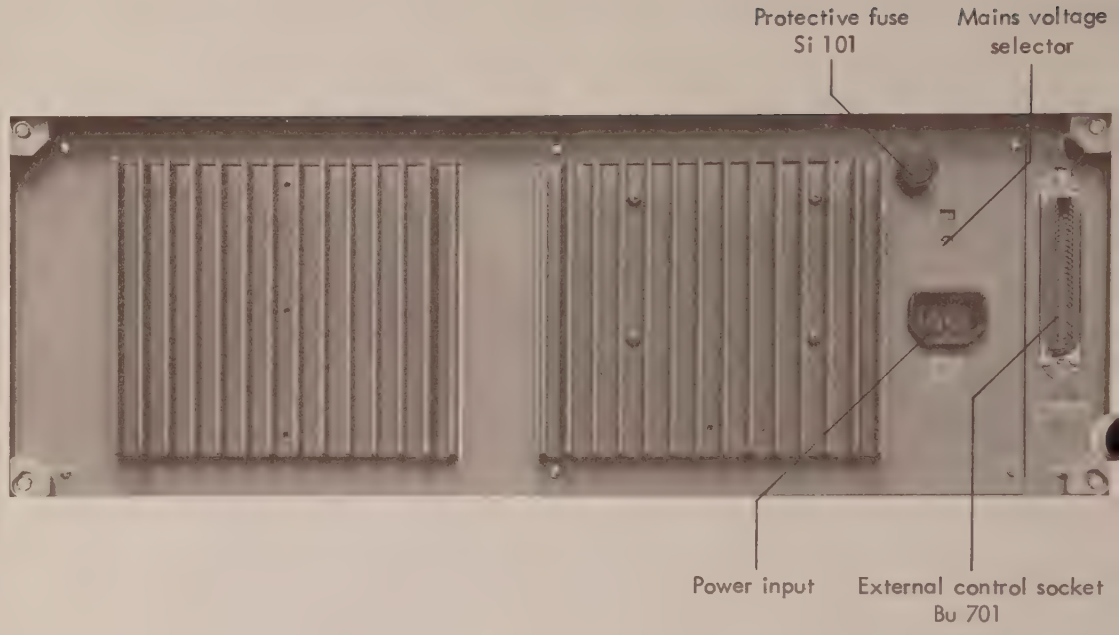


Fig. 2-2 Rear view of the White Noise Generator RS-50

2. OPERATION

The White Noise Measuring Set RK-50 consists of the separate units

- White Noise Generator RS-50 with Band-Limiting Filters RSB and Band-stop Filters RSS
- White Noise Receiver RE-50 with Converter Plug-ins REU

If required, it can be extended by addition of the

- Wideband Level Meter REB-50

The bench mounting models of these units can be used in a horizontal position or tipped slightly (front panel approx. 30 ° from vertical) by swinging out the supporting stand.

After installation of 19" mounting brackets the units can also be installed in 19" racks.

The operating characteristics of the units used in the White Noise Measuring Set RK-50, specified in chapter 1. TECHNICAL SPECIFICATIONS, are valid only when the defined rated operating conditions are maintained.

In particular, the measuring set should be operated at ambient temperature between +5 and +40 °C. Use at temperatures outside of this range is not permissible.

All important controls and indications for manual operation and the inputs and outputs are mounted on the front panels of the units. The power input and sockets for remote or programme control are located on the rear of the units.

The abbreviations for switches, sockets, lamps, etc. used in the operating instructions are shown on the fold-out figures 2-1 to 2-4 and in figures 2-8 and 2-10. These abbreviations correspond to those, used in the circuit diagrams, component diagrams and parts lists.

2.1. Connecting filters and converters to Measuring Set RK-50

In accordance with the principle of white noise measurement as described in the INTRODUCTION the White Noise Measuring Set RK-50 must be fitted with the corresponding filters and converter plug-ins.

The selection of the filters etc. can be based on international recommendations, particularly those of the CCITT/CCIR. Table 2-1 shows a summary of the recommended measuring frequencies - for in-band and for out-of-band measurements - for the various systems.

The use of the table and the transformation of the table values into specifications of filter and converter plug-ins is best explained with the aid of an example.

Example: Which filters and converter plug-ins are required for measurements on a 300 channel radio-link system?

Table 2-1 shows:

Noise band:		60-1296 kHz
Measuring frequencies	in-band:	70, 270, 534, 1248 kHz
	out-of-band:	50, 1549 kHz

In most cases it will be sufficient to select only some of the recommended frequencies, and in the above example the value 270 kHz or 534 kHz, for example, could be omitted.

This results in the following configuration of the White Noise Measuring Set RK-50 for in-band measurements.

White Noise Generator RS-50:

Band-Limiting Filter RSB-60/1296
Bandstop Filters RSS-70, RSS-534, RSS-1248

White Noise Receiver RE-50:

Converter Plug-ins REU-70, REU-534, REU-1248

Table 2-1 also shows that the measuring frequencies, determined in the example above, would also cover certain systems with a smaller number of channels and that would only be necessary to switch in a different Band-Limiting Filter RSB. It is possible to fit the Generator RS-50 with several band-limiting filters. If the filters and converter plug-ins are correctly selected then white noise measurements can be carried out on 3 different CF transmission systems by simple push button selection of the bands.

Other possible applications result from the fact that all out-of-band bandstops can also be used for in-band measurements. Table 1-5 in chapter 1. TECHNICAL SPECI-

FICATIONS shows whether the bandstop filters can be used only singly or in simultaneous combinations of bandstops. Table 1-5 should be complied with in all cases.

	Number of channels	Noise band kHz	Recommended measuring frequencies in the band kHz							Out-of-band kHz	
Radio-link, cable (symm.)	12	6-54	16								
	12	6-60	16	57							
	24	6-108	16	57	98						119
	12	12-60	16	57						10	
	24	12-108	16	57	98					10	119
	60	12-252	16	57	98	230				10	
	120	12-552	16	57	98	270	534			10	600
Satellite-link	24	12-108	16	98							
	36	12-156	16	140							
	60	12-252	16	240							
	72	12-300	16	270							
	96	12-408	16	240	394						
	132	12-552	16	240	534						
	192	12-804	16	394	770						
	252	12-1052	16	534	1002						
	312	12-1296	16	534	1248						
	432	12-1796	16	534	1002	1730					
	612	12-2600	16	770	1730	2438					
	792	12-3284	16	1002	2438	3150					
	972	12-4100	16	1002	2438	3886					
	1092	12-4892	70	1002	2438	4650					
	1872	12-8160	70	1002	3150	5340	7600				
Radio-link, cable (coaxial)	60	60-300	70	270						50	331
	120	60-552	70	270	534					50	600
	240	60-1052	70	270	534	1002				50	1549
	300	60-1296	70	270	534	1248				50	1549
	600	60-2600	70	270	534	1243	2438			50	3200
	960	60-4100	70	270	534	1248	2433	3886		50	4715
	1260	60-5600	70	270	534	1248	2438	3886	5340	50	6300
	900	316-4100	534	1248	2438	3886				270	4715
	1200	316-5600	534	1248	2438	3886	5340			270	6300
	1800	316-8160	534	1248	2438	3886	5340	7600		270	9073
	2700	316-12360	534	1248	2438	3886	5340	7600	11700	270	13677

Table 2-1 Measuring frequencies for the various bands or systems

2.1.1. Band-Limiting Filters RSB

Up to 3 Band-Limiting Filters RSB can be fitted in the White Noise Generator RS-50 (see Fig. 2-1). Any combination of the band-limiting filters specified in table 1-2 is possible.

All necessary electrical connections are made internally when the filters are plugged in.

Guide rails simplify insertion of the filters. Each band-limiting filter should be secured against inadvertant removal by means of the screw at the lower edge of the filter front panel. If less than 3 band-limiting filters are used the vacant positions can be covered with dummy panels.

2.1.2. Bandstop Filters RSS

For mounting Bandstop Filters RSS in the White Noise Generator RS-50 there are 6 positions (see Fig. 2-1). The filters are inserted and secured in the same way as the band-limiting filters (section 2.1.1.).

The band-stop filters with double-width front panels, particularly RSS-5340 (BN 728/2), RSS-7600 (BN 732/2), and RSS-11700 (BN 736/2), which can not be mounted directly in the generator, and all bandstop filters in the RK-5 series, can be inserted in the signal path of the White Noise Generator RS-50 by means of the Bandstop Filter Adapter RSSA-50.

The Bandstop Filter Adapter RSSA-50 is installed in the Generator RS-50 in the place of a bandstop filter. The bandstop filter is attached to the adapter by means of 2 coaxial cables whereby care should be taken that the adapter output $\dashv\bullet$ and the bandstop filter input $\rightarrow\bullet$ and the bandstop filter output $\bullet\rightarrow$ and the adapter input $\bullet\dashv$ respectively are connected together.

The generator is externally controlled by the Receiver RE-50. Then only one bandstop filter may be connected to the filter adapter (see also section 2.5.), as the plug-in positions 1...6 for the bandstop filters are assigned rigidly to the positions 1...6 of the Converter Plug-ins REU in the receiver, in this case.

If the Generator RS-50 and the Receiver RE-50 are operated separately and insert other applications, e.g. control by a programme control and evaluation unit, then

several bandstop filters can be connected to one filter adapter. The external filters are connected together by means of coaxial bridging plugs (connectors: 2,5/6 (M)). The input and output of the bandstop filter chain are connected to the filter adapter as described above.

The selected bandstop filters must be installed in the White Noise Generator RS-50 in descending frequency sequence from right to left. This sequence should also be observed when bandstop filters are connected via the Filter Adapter RSSA-50. If less than 6 bandstop filters are used then these should be inserted in the right most plug-in positions.

Vacant plug-in positions can be covered with dummy panels.

2.1.3. Converter Plug-ins REU

A maximum of 6 Converter Plug-ins REU can be installed in the White Noise Receiver RE-50.

All plug-ins have identical dimensions and are fitted with the same locking mechanism. If a converter plug-in is to be changed, then it is removed by depressing the locking catch of the plug-in and pulling it out by means of the retaining handle which springs out of the panel. When inserting a new plug-in into the receiver it should be slit in on the guide rails as far as it will go. Then depress the retaining handle until the locking catch snaps into place. In addition to the mechanical interlock all necessary electrical connections between the plug-in and the basic unit are thus made.

Care should be taken that the converter plug-ins in the Receiver RE-5 are in a descending frequency sequence from right to left. If less than 6 converter plug-ins are used they should be placed in the right most plug-in positions.

2.2. Mains connection and preliminary settings

The units of the White Noise Measuring Set RK-50 can be operated from A.C. mains with frequencies between 45 and 66 Hz.

The units are set up for operation from 220 V mains supplies when delivered from the factory. If they are to be operated from mains supplies with the voltages 110, 117,

127, 227 or 235 V, then the mains voltage selector on the rear of each unit should be adjusted with the aid of a screwdriver until it shows the required voltage value in the window above the mains voltage selector (to the right of the voltage selector on the REB-50).

If the White Noise Receiver RE-50 or the Wideband Level Meter REB-50 is switched to a voltage other than 220 V it is not necessary to change the fuse insert.

It is, however, necessary, to change the fuse on the White Noise Generator RS-50 if it is switched to the voltage values 110, 117, or 127 V. The fuse T 0.5 B, located in the fuse holder, should be replaced by a fuse T 1 B (1 A, slow blow) after removal of the fuse holder cover.

In accordance with protection class I to VDE 0411 the protective conductor contact of the mains plug on all units of the white noise measuring set should be connected to the cabinet ground so that this is connected to ground potential when the units are plugged in.

Connection to the mains is carried out with the mains cable supplied with the units. After operation of the main switch ("ON" position shown by red field behind the switch) the units of the measuring set are immediately ready for operation.

2.3. Operation of the White Noise Generator RS-50

2.3.1. Selection of the noise band

The wideband noise signal in the frequency range 6 kHz to 12.5 MHz which is produced by the generator is limited by means of Band-Limiting Filters RSB to a band width which corresponds to one of the basebands of the CF transmission systems (up to 2700 channels).

The band limiting filters installed in the White Noise Generator RS-50 are switched on with the switches S 702/I, S 702/II, and S 702/III. These 3 switches are mutually interlocked so that only 1 band-limiting filter is switched on at one time.

2.3.2. Switching the bandstops in and out

The Bandstop Filters RSS are used for generation of one or more (max. 6) slots in the noise spectrum. Selection and fitting of these is carried out in accordance with section 2.1.2.

The switches S 703 to S 708 (from left to right) are assigned to the 6 plug-in positions in the Generator RS-50 for installation of bandstop filters. Switch position "on" indicates pre-selection of the corresponding bandstop filter. Both, single bandstop filters or combinations of filters can be used.

The pre-selected bandstop filters are switched in and out by means of the switch S 701/III consisting of two push buttons. This switch has priority over the bandstop pre-selection switches S 703 to S 708.

2.3.3. Output level

The coarse adjustment of the output level is carried out with switch S 709. Levels between -50 and +5 dBm can be selected in steps of 1 dB in combination with the horizontal level scale.

Switch S 801 is provided for fine adjustment of the output level in 0.1 dB steps. The switch has a setting range of 0 to - 1 dB.

The actual level available at the generator output Bu 704 is the result of algebraic addition of the two selected level values, provided that matching is correct ($R_L = Z$).

The output level range can be increased by 10 dB to - 40 to + 15 dBm by operation of the switch S 701/IV. [1)]

A regulation circuit keeps the output level constant regardless of the bandwidth of the selected noise band. It also prevents the output level from dropping off by the insertion loss [2)] of the bandstops, when these are switched in.

The level regulation lamp SL 701 is lit whenever the selected and actual output level.

2.3.3.1. Setting the nominal power level

For S/N measurements (see section 2.4.4.1.) the term nominal power level $p_{\Sigma, N}$ place an important part. It can be explained as follows:

1) Only advantageous when the sum of the insertion losses of the switched-in bandstop filters does not exceed 2 dB within the selected noise band.

2) The insertion loss of a bandstop filter comprises the pass band insertion loss, a_G, of the bandstop filter plus the stop-band power loss, a_L, due to the slot. See Tables 1-5 and 1-6.

The noise signal produced by the Generator RS-50 is intended to simulate the average loading of a busy CF transmission system. The average loading which depends on the number of channels in the system and is called the level of the conventional load $p^{*}_{\Sigma, C}$ (also called Holbrook-Dixon addition) is calculated as follows:

$$p^{*}_{\Sigma, C} = \begin{cases} 4 \log n - 1 \text{ dBm0} & \text{for number of channels } n < 240 \\ 10 \log n - 15 \text{ dBm0} & \text{for number of channels } n \geqq 240 \end{cases}$$

This level would have to be applied to the system as an absolute measured power at a zero transmission level point (0 TLP).

As the noise signal is, however, normally inserted at position which have a transmission level other than zero, this must be taken into account when setting up the output level of the White Noise Generator RS-50.

The nominal power level, which should actually be set up at the White Noise Generator RS-50, is calculated by algebraic addition of the transmission level p_C at the point of insertion and the level of the conventional load $p^{*}_{\Sigma, C}$:

$$\boxed{p_{\Sigma, N} = p_C + p^{*}_{\Sigma, C}}$$

In this case $p_{\Sigma, N} = 10 \lg \frac{P_{\Sigma, N}}{1 \text{ mW}}$ where $P_{\Sigma, N}$ is the power emitted by the generator. The valid conventional load for the various noise bands (= systems) are specified on the front panels of the Band-Limiting Filters RSB.

Example: 300 channel system

Transmission level of the insertion point	= - 42 dBr
Level of the conventional load	= + 9.8 dBm0
Nominal power level to be selected	= - 32.2 dBm

2.3.3.7. Blocking the generator output

The spring loaded switch S 701/1 should be operated when the generator output is to be blocked for measurement of the intrinsic noise of the connected test object. The level regulation lamp SL 701 extinguishes when the generator output is blocked.

The input of the system remains terminated.

2.3.4. Generator output

The noise signal of the Generator RS-50 is available at the coaxial output socket Bu 704, whose output impedance is 75 Ω.

The output is fitted with the universal socket Versacon ® 9 in which adapters for all common coaxial connection systems for telecommunications can easily be screwed.

The frequency range, 6 kHz to 12.5 MHz, of the white noise generator allows the connection of all coaxial 75 Ω systems up to 2700 channels.

A special matching transformer is necessary for connection of the White Noise Generator RS-50 to symmetrical 150 Ω systems in the frequency range 6 to 600 kHz (see section 2.7.).

2.4. Operation of the White Noise Receiver RE-50

2.4.1. Receiver input

The test object is to be connected to the coaxial input socket Bu 201, whose input impedance is 75 Ω.

Similarly to the Generator RS-50 the White Noise Receiver RE-50 is suitable for connection to coaxial 75 Ω systems with up to 2700 channels. Its frequency range, 10 kHz to 14 MHz, covers the range between the lowest (10 kHz) and the highest (13677 kHz) measuring frequencies.

Measurements on symmetrical 150 Ω systems in the frequency range 6 to 600 kHz are possible if the special matching transformer 150 Ω symm./75 Ω coax. is used (see section 2.7.).

For high impedance measurements on coaxial or symmetrical systems the Test Probe TK-9 (coax.) or the Decoupling Transformer REÜ-4 (symm.) can be used for decoupling (see section 2.8.).

The conversion of the input to other coaxial socket systems is carried out as described in section 2.3.4.

2.4.2. Selection of the measuring frequency

The White Noise Receiver RE-50 is a selective level meter, whose measuring frequencies between 10 kHz and 13.677 MHz is determined by the easily exchanged Converter Plug-ins REU (see section 2.1.3.).

The selection of one of 6 possible measuring frequencies (= switching in the corresponding converter plug-in) is carried out with switch S 301. The switch positions and the plug-in positions for the converters are assigned to each other. An indicator lamp is illuminated on the selected converter plug-in.

2.4.3. Signal weighting

The White Noise Receiver RE-50 indicates white noise in the 3.1 kHz wide speech channel with psophometric weighting. The indication is thus equal to that of an r.m.s. meter with a bandwidth of 1.74 kHz (equivalent noise bandwidth).

2.4.4. Measurements

2.4.4.1. S/N mode

In S/N mode the following parameters can be determined directly with the White Noise Receiver RE-50:

- relative noise in a speech channel of a CF system, measured on the pW0p scale
- Level of the relative noise, measured on the dBm0p scale
- Signal-to-noise ratio S/N (S/N is the difference between the noise level in the speech channel and the transmission level at the measuring point; the numerical value of the S/N ratio is thus equal to that of the level of the relative noise)

If only a simple checking of a CF transmission path is to be carried out then S/N measurements for various measuring frequencies should be carried out with a correctly adjusted nominal power level on the generator.

Step-by-step description of the measuring operation (settings on the generator are specially marked):

- Connection of the test object
- Generator RS-50: Adjustment of the nominal power level (see section 2.3.3.1.).
- Set the measuring mode/system parameter switch S 501 to the number of channels of the system to be measured

- Selection of the measuring frequency with switch S 301
- Generator RS-50 : switch out Bandstop Filter(s) RSS [1)]
- Set measuring range switch S 603 to position ▼
- Set the reference level switches S 601 and S 602 to the transmission level of the measuring point to which the Receiver RE-50 is connected
- The meter J 801 must indicate position ▼ (reference measurement)

Note : If the nominal power level on the generator side and the transmission level on the receiver side are correctly set, but the meter indication is not ▼ then this means that the actual transmission level at measuring point does not agree with the nominal transmission level. The transmission level should be corrected with the reference level switches S 601 and S 602 until the meter needle points to the reference mark ▼ : then measurement of S'/N.

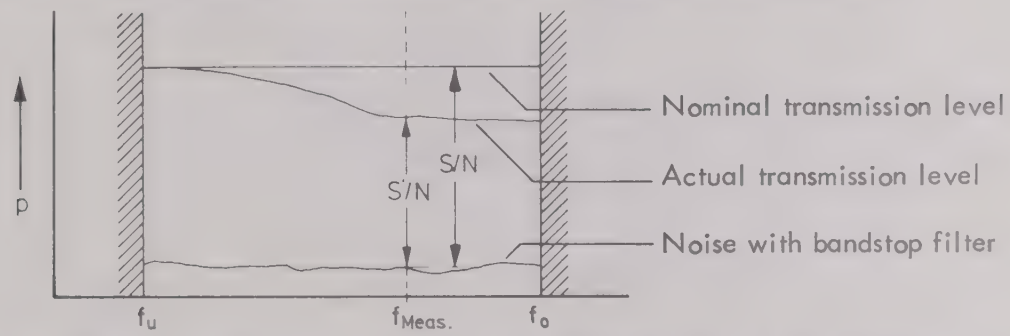


Fig. 2-5 Signal-to-noise ratio with and without compensation of the incorrect transmission level

- Generator RS-50 : Switch in Bandstop Filter (s) RSS [1)]
- Pointer of the meter J 801 moves towards zero
- Adjust the measuring range switch S 603 clockwise until a readable indication is attained on the meter
- Determination of the measured result, using the calculation aids on the instrument
- Relative noise level : $\boxed{\alpha + a \text{ dBm0p}}$

  α = Pointer indication on upper meter scale

  a = Selected measuring range on the left scale of the measuring range switch

Relative noise : $\boxed{\beta \times b \text{ pW0p}}$

β = Meter indication on upper meter scale

b = Selected measuring range on the right scale of the measuring range switch

Signal-to-noise ratio S/N : $\boxed{-(\alpha + a) \text{ dB}}$

1) When Generator RS-50 is remotely controlled from Receiver RE-50, the switching in and out of a bandstop filter is coupled with the resetting of the measurement range switch S 603 (S 603 in position ▼ : bandstop filter out; remaining position of S 603 : bandstop filter in). Also see para. 2.5.

For complete judgement of the transmission quality it is recommended to carry out S/N measurements at a single measuring frequency as a function of system loading, i.e. of the overload P_U. If the actual measured values are drawn in a graph against P_U, then a curve similar to that in Fig. 2-6 is obtained.

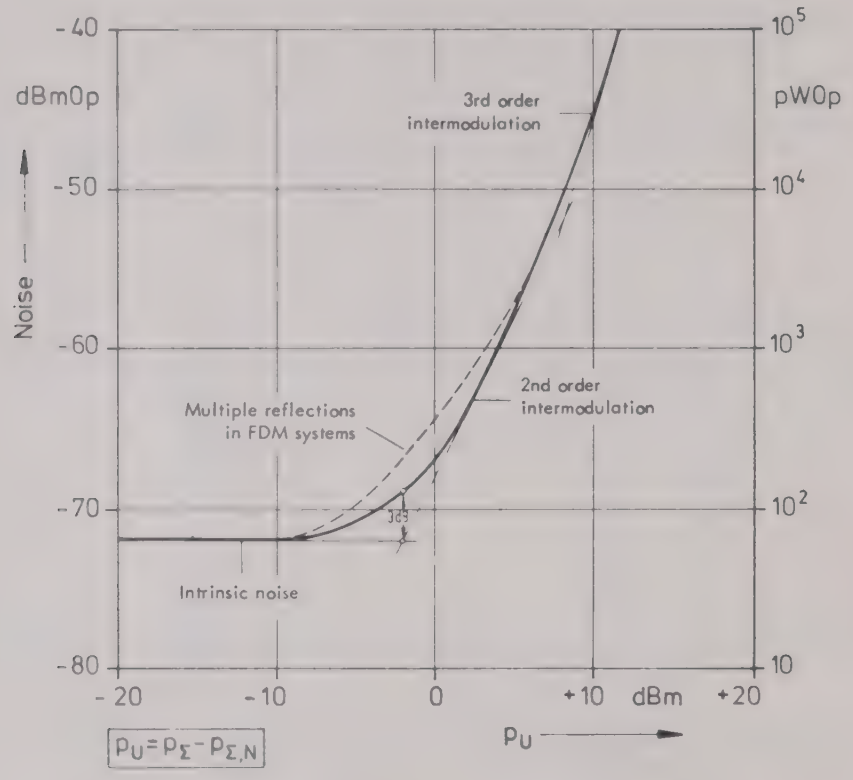


Fig. 2-6 Characteristic noise increase with increasing system loading

At low loading only the intrinsic noise appears. As the loading is increased, then the intermodulation noise also increases and, particularly after the conventional load is exeeded. As a rule the noise increases by 2 dB per dB overload at low overloading due to 2nd order intermodulation components and by 3 dB per dB overload due to 3rd order components for heavy overloading.

In systems using frequency modulation, multiple reflections in the IF or RF path, particularly at the upper end of the baseband, cause sharp differencies in the noise distribution, approximately as shown by the dotted line in Fig. 2-6.

Even at low loading 3rd order intermodulation products can appear. This is particularly the case, when measurements are carried out over long paths whereby the 3rd order

components are added as voltages and their sum thus forms the main section of the measured noise. 2nd order intermodulation products, on the other hand, are noticeable on short transmission paths, as they are normally added as power.

Noise measurement at various measuring frequencies gives information about the frequency dependance of the noise and thus allows conclusions as to possible sources of error. The noise at conventional load should be approximately equal for all measuring frequencies, as the predominance of the low frequencies is compensated by the preemphasis. Similarly the sharp rise of the noise level should occur for all measuring frequencies at approximately the same overload P_U. If 2nd order modulation components predominate in the lower channels then this is an indication of distortion in the modulators and amplifiers. A noise increase in the upper channels, on the other hand, can be caused, in systems with frequency modulation, by variations of the group delay.

Measurement of the actual transmission level in the position ▼ of the measuring range switch S 603 at various measuring frequencies is also interesting, because the values thus determined can provide information about the frequency characteristic of the test object.

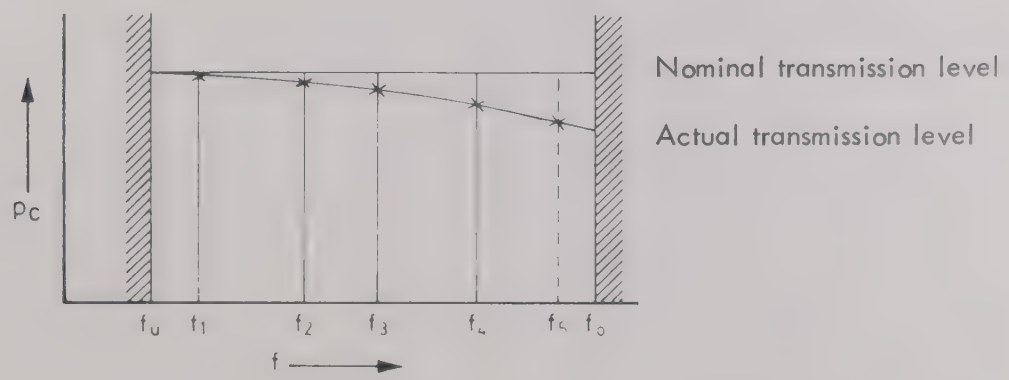


Fig. 2-7 Frequency characteristic of the transmission level

2.4.4.2. NPR mode

To determine the noise power ratio NPR the difference between

the level of the noise power density in a non-blocked measuring channel and

the level of the noise power density in a blocked measuring channel are measured.

It is more advantageous to measure the difference of one channel in the two conditions so that only a bandstop filter needs to be switched in and out.

Step-by-step description of the measuring operation (Adjustments on the Generator RS-50 are specially marked):

- Connection of the test object
- Generator RS-50: Adjustment of the output level
- Measuring mode/system parameter switch S 501 to position NPR
- Selection of the measuring frequency with switch S 301
- Generator RS-50: switch out Bandstop Filter RSS [1)]
- Set measuring range switch S 603 to position ▼
- Set the meter pointer to the reference mark ▼ by adjustment of the reference level switches S 601 and S 602
- Generator RS-50: switch in Bandstop Filter RSS [1)]
- Meter pointer moves towards zero
- Change the setting of the measuring range switch S 603 clockwise until a readable indication on the meter is obtained
- Determination of the measured result, using the calculation aids on the meter

Noise power ratio NPR: $\boxed{\alpha + a\ dB}$

α = pointer indication on upper meter scale

a = selected measuring range on left scale of the measuring range switch

Note: The Receiver RE-50 indicates - NPR, i.e. increasing noise power ratio means a more negative indication. This method was selected as the main object of white noise measurements is to determine the noise rather than the signal which is being distorted.

2.4.5. Headphone output

Socket Bu 604 is provided for connection of a headphone. Monitoring of the measuring channel with headphones allows the detection of discrete spectral components, which falsify the measured result.

When the meter J 801 indicates 0 dB, an open circuit voltage v_{rms} of approximately 275 mV is available with an output impedance of 600 Ω.

1) See foot-note on page 2-15

2.4.6. Recorder output

A line recorder (such as the three-line recorder Z 398, made by Metrawatt) can be connected to socket Bu 801 for recording the noise level in the measured channel.

The open circuit voltage for full-scale deflection of the meter J 801 can be adjusted to values between 0 and 200 mV with the aid of potentiometer P 810. The voltage at the recorder output is proportional to the deflection of the meter, and the display range is approx. 30 to 40 dB. The output impedance of the output is approx. 2.4 kΩ.

2.4.7. AF output I

The AF output I socket Bu 501 is connected directly after the REU output and the AF filter, i.e. directly after selection of the measuring frequency from the wideband RF signal and conversion into the AF range.

In S/N mode a standardized transmission level of -40 ± 2.2 dBr is available at the REU input in any position of the measuring range switch S 603 between -70 and -20 (or 10^2 and 10^7). For NPR mode the level is - 50 ± 2.2 dBm. As the amplification between the REU input and the REU output in all above mentioned switch positions is 60 dB a standardized level increased by this value is available at the AF output I.

A possible application of this output is the connection of the Noise Monitor Set GU-1. In this case the advantages of the measuring point selector in the Monitor Set GU-1 and the possibility of programme-controlled measuring frequency selection in the Receiver RE-50 could be utilized particularly for continuous monitoring of several radio-link systems.

2.4.8. AF output II

The AF output II Bu 603 is intended for connection of the Digital Level and Noise Measuring Set PMD-1, made by Wandel u. Goltermann or of a similar instrument from another firm. Noise level measurements in the range - 90 to - 10 dBm0p are possible in any position of the measuring range switch S 603 between - 70 and - 20.

The corresponding level range of the open circuit voltage at the AF output II is -79 to + 1 dB. On the noise level meter, which should be connected with high impedance the relative level switch should be adjusted, so that the indicated measured result is the same on the Receiver RE-50 and the noise level meter.

An automatic digital measured result display is attanied by connection of the Level and Noise Measuring Set PMD-1.

2.5. External control of the generator by the receiver

If the Generator RS-50 and the Receiver RE-50 are used at the same location, a considerable simplification of operation can be attained by installing an external control connection between the sockets Bu 301 of the receiver and Bu 701 of the generator with the cable K 176, which can be supplied on request.

When this is done, the selection of a Converter Plug-in REU, located in one of the plug-in positions 1...6 in the Receiver RE-50, causes pre-selection of the Bandstop Filter RSS in the corresponding position 1...6 of the generator. It should therefore be emphasized that the sequence of the bandstops in the generator and the converter plug-ins in the receiver should be identical.

In addition, the switching in and out of the pre-selected Bandstop Filter RSS is controlled by the Receiver RE-50. In the reference position ▼ of the measuring range switch S 603 the pre-selected bandstop is switched out; in all other positions it is switched in.

When the Generator RS-50 is externally controlled, the bandstop pre-selection switches S 703...S 708 and the switch "Bandstop in/out" S 703/III are inoperative and the indicator lamp SL 702 is illuminated. [1)]

2.6. Operation of the Wideband Level Meter REB-50

The Wideband Level Meter REB-50 is used for measurement of the wideband total level, i.e. the baseband loading of the system to be measured. It can be used both on the generator side and on the receiver side. The frequency range of the Wideband Level Meter REB-50 is from 6 kHz to 30 MHz. The rectifier operates on the thermal principle and forms the r.m.s. value of the applied signal.

1) SL 702 is eliminated in Series A

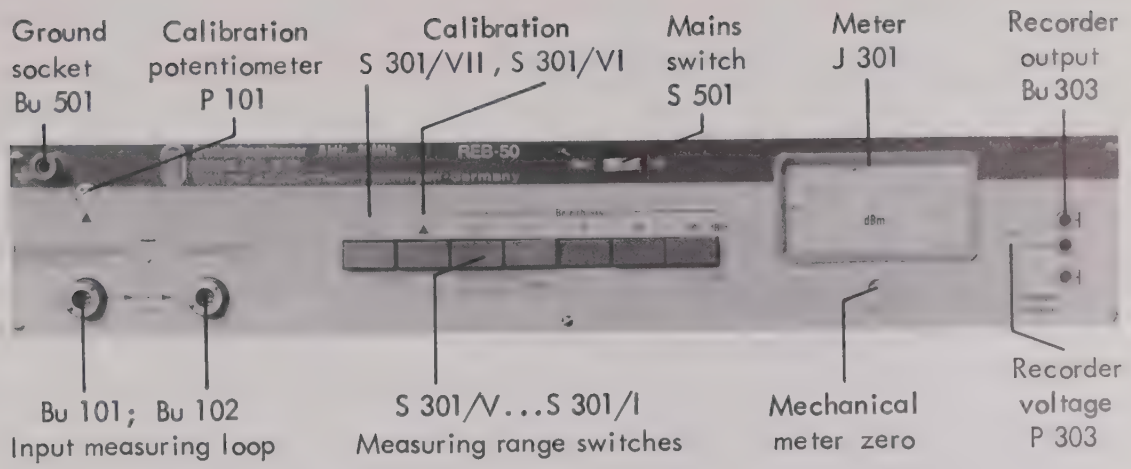


Fig. 2-8 Front view of the Wideband Level Meter REB-50

2.6.1. Calibration

Two marks are provided on the meter J 301 for calibration of the wideband level meter. First the button " △ " (S 301/VII) is depressed and the pointer set to the mark " △ " with the aid of the mechanical meter zero. When the button " ▲ " (S 301/VI) is depressed, then the pointer of the meter set to the mark " ▲ " with the aid of the calibration potentiometer P 101.

If the settings deviate too far from the setting marks before calibration procedure, then probably first the REB-50 must be aligned.

2.6.2. Measuring

The input of the wideband level meter consists of a 75 Ω loop (Bu 101, Bu 102) to which the level meter is coupled at high impedance. The test object is connected to socket Bu 101. The measuring loop is normally terminated at socket Bu 102 by the coaxial input of the White Noise Receiver RE-50 (the input level at the Receiver RE-50 is reduced by the insertion loss of the input loop, which is approx.0.2 dB).

If the wideband level meter is used on the generator side the output Bu 704 of the Generator RS-50 is connected to the socket Bu 101, the test object terminates the input loop at socket Bu 102. When setting up the generator output level, the insertion loss of the input loop should be taken into account.

If the wideband level meter is to be connected into an existing line, then the input line should be connected to the socket Bu 101, and the outgoing line to the socket Bu 102.

When measuring at the ends of lines the system should be terminated by means of a pluggable resistor on socket Bu 102.

The selction of the measuring range is carried out with the push buttons S 301/I... S 301/V. Measuring ranges of - 30, - 20, - 10, 0 or + 10 dBm for a 0 dB indication on the meter J 301 can be selected. The meter has an indication range from -20 to + 1 dB. A protective circuit prevents damage to the meter, if the wrong measuring range is selected. The total measuring range of the wideband level meter from -50 to + 11 dBm results from the algebraic addition of the measuring range and the pointer indication.

Wideband level measurements on symmetrical 150 Ω systems in the frequency range 6 to 600 kHz can be carried out with a special matching transformer 150 Ω symm./ 75 Ω coax. (see section 2.7.).

For high impedance wideband level measurements on coaxial or symmetrical systems the Test Probe TK-9 (coax.) or the Decoupling Transformer REÜ-4 (symm.) can be used. Both of these units have a decoupling attenuation of 20 dB (see section 2.8.)

An additional scale on the measuring range selection switch S 301/... takes into account the decoupling attenuation of the test probe or transformer. In this case the measuring ranges - 10.0 or + 10 dBm (for 0 dB meter indication) can be selected. The measuring range of the Wideband Level Meter REB-50 extends from -30 to +11 dBm for high impedance measurements.

2.6.3. Recorder output

A line recorder can be connected to socket Bu 603 for registration of the wideband level. For a 0 dB indication of the meter J 301 an open circuit voltage between 0 and 250 mV can be set up with the aid of potentiometer P 303. The output impedance of the output is 2.5 kΩ.

In the case of continuous monitoring of operational systems the use, for example, of the three-line recorder Z 398, made by Metrawatt, or of a similar device, allows simultaneous recording of the total level (measured with REB-50) which varies considerably during the day, and of the noise of an out-of-band-channel (measured with RE-50).

2.6.4. D.C. output

Pins a and c of the output Bu 302 on the rear of the unit are provided for the connection of a recorder which requires a higher voltage (or of an analog digital converter, or oscilloscope, etc.). At a 0 dB indication of the meter J 301 open circuit voltages between 0 and 5 V can be set up with potentiometer P 302. The output impedance is less than 1 kΩ.

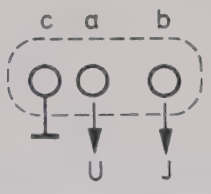


Fig. 2-9 Socket Bu 302, seen from the contact side

Pins b and c form a D.C. voltage output for current supply of low impedance circuits. The short circuit current is 0 to 70 µA, depending on the open circuit voltage set up with potentiometer P 302.

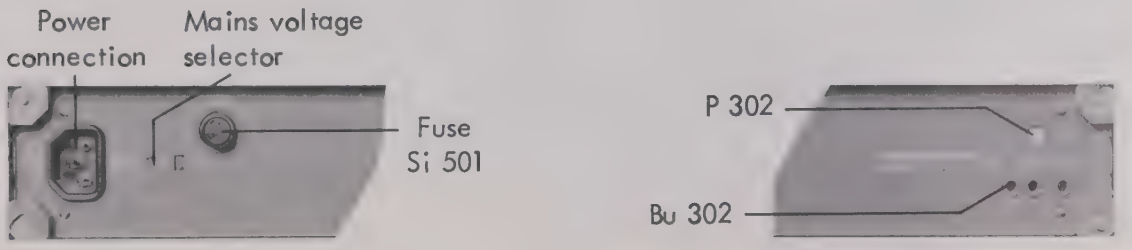


Fig. 2-10 Rear view of the Wideband Level Meter REB-50

2.7. Measurements on symmetrical 150 Ω systems

White noise measurements on symmetrical 150 Ω systems in the frequency range 6 to 600 kHz can be carried out with the aid of the matching transformer, which is available on request.

Fig. 2-11

Matching transformer 150 Ω symm./75 Ω coax.

The attenuation of the power level of = 0.2 dB due to the insertion of the transformer in the signal path should be taken into account (e.g. with the fine reference level switch).

Fig. 2-12 and 2-13 show connection possibilities for the matching transformer on the generator and the receiver sides.

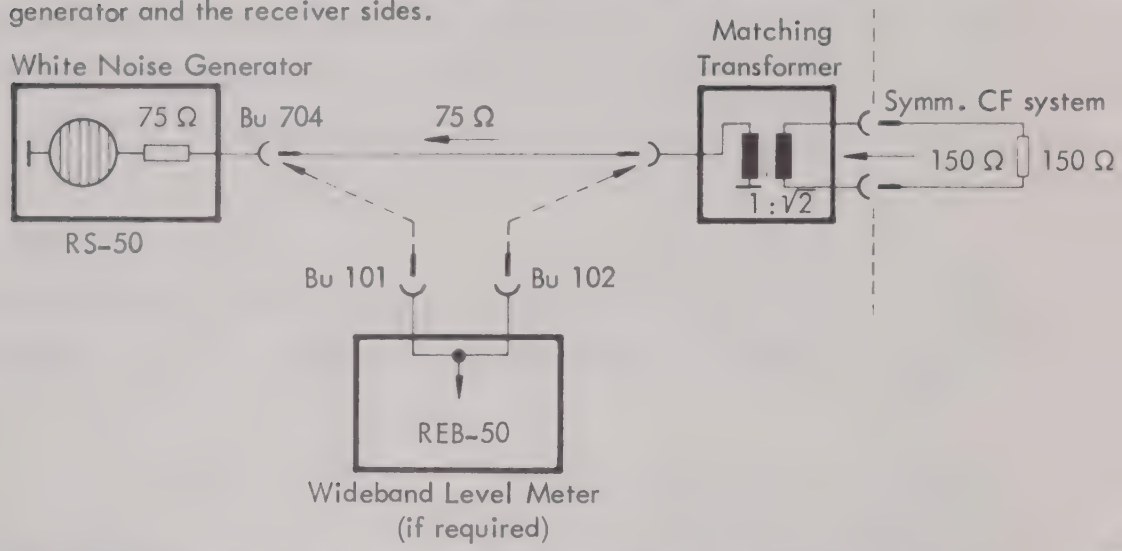


Fig. 2-12 Connection of the matching transformer on the generator side

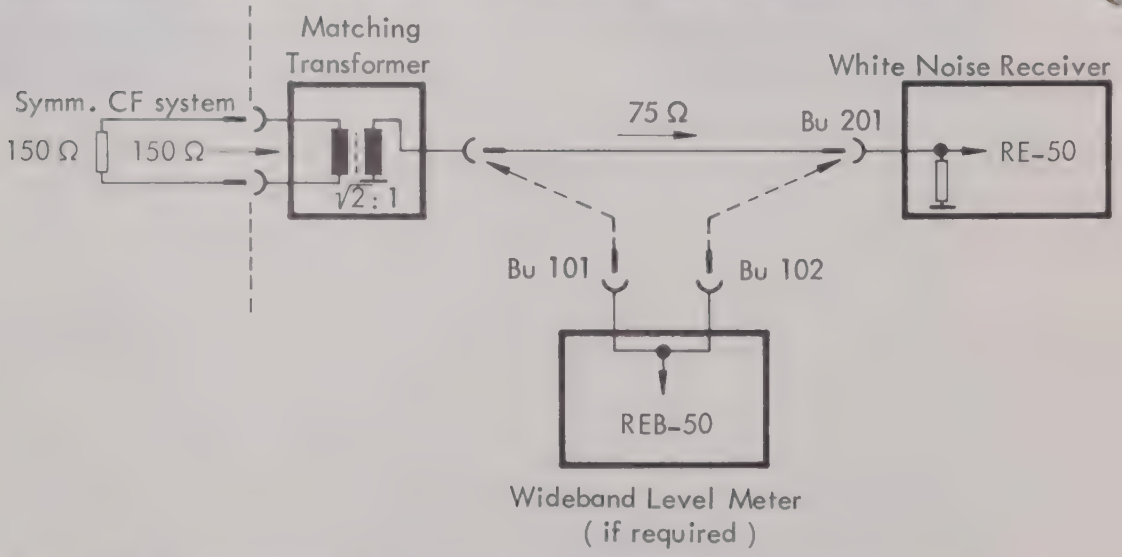


Fig. 2-13 Connection of the matching transformer on the receiver side

2.8. High impedance measurements

2.8.1. Test Probe TK-9

High impedance measurements on coaxial systems are made possible by the use of the Test Probe TK-9. This test probe has a decoupling attenuation of 20 dB, and the at-

tenuation error is ± 0.1 dB max. in the frequency range from 50 kHz to 13 MHz, in range 13 to 15 MHz it is insignificantly larger. The decoupling attenuation can be taken into account by means of the transmission level setting on the Receiver RE-50 so that the measured values - as present at the tip of the test probe - can be read off direktly from the measuring range switch and the meter of the receiver. A system transmission level of -15 dBr, for example, would thus require a transmission level setting of -35 dBr when the decoupling attenuation is taken into account.

Fig. 2-14 Test Probe TK-9

The measuring configuration, when using the Test Probe TK-9, shown in Fig. 2-15:

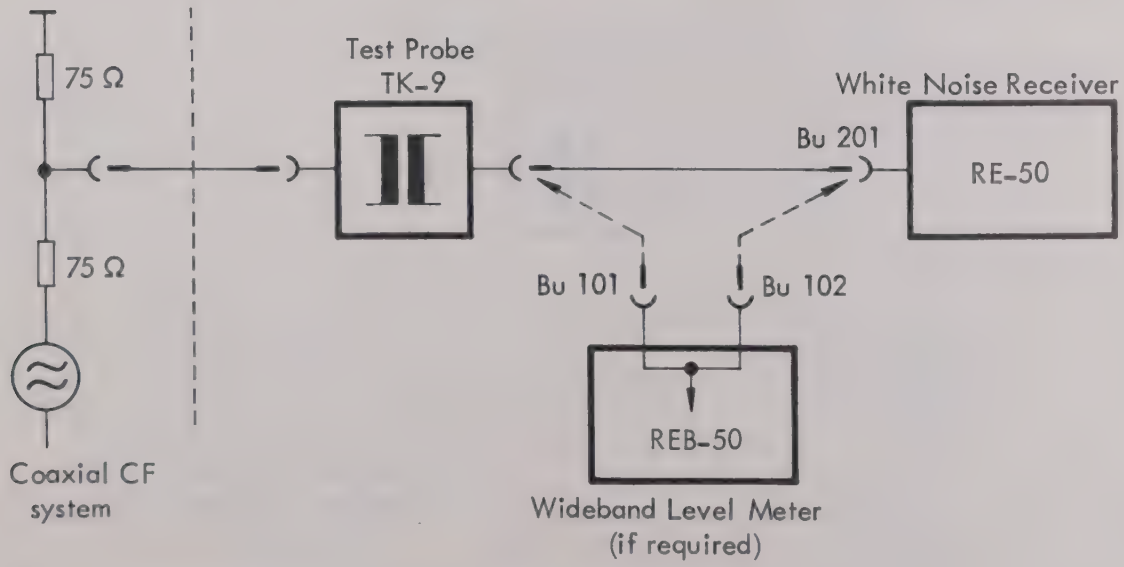


Fig. 2-15 High impedance measurements on coaxial systems

2.8.2. Decoupling Transformer REÜ-4

This transformer permits high impedance measurements on symmetrical 150 Ω systems with the White Noise Receiver RE-50. The REÜ-4 should be connected as close as possible to the system output, and a 75 Ω coaxial cable used for connection of the transformer output and the receiver input.

The attenuation of the power level by the transformer is 20 dB.

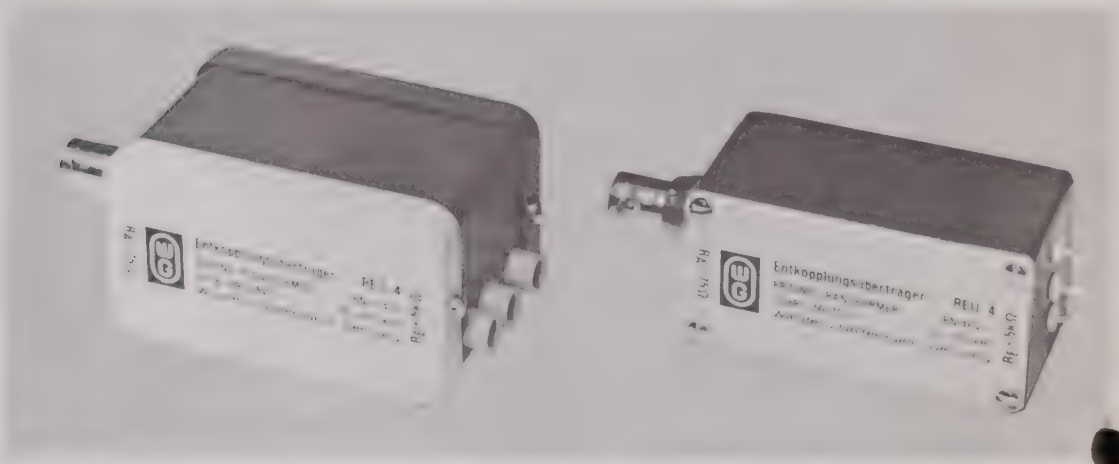


Fig. 2-16 Decoupling Transformer REÜ-4 (BN 464/2 and BN 464/1)

In order to be able to read the measured value at the transformer input directly from the measuring range switch and the meter of the white noise receiver, the decoupling

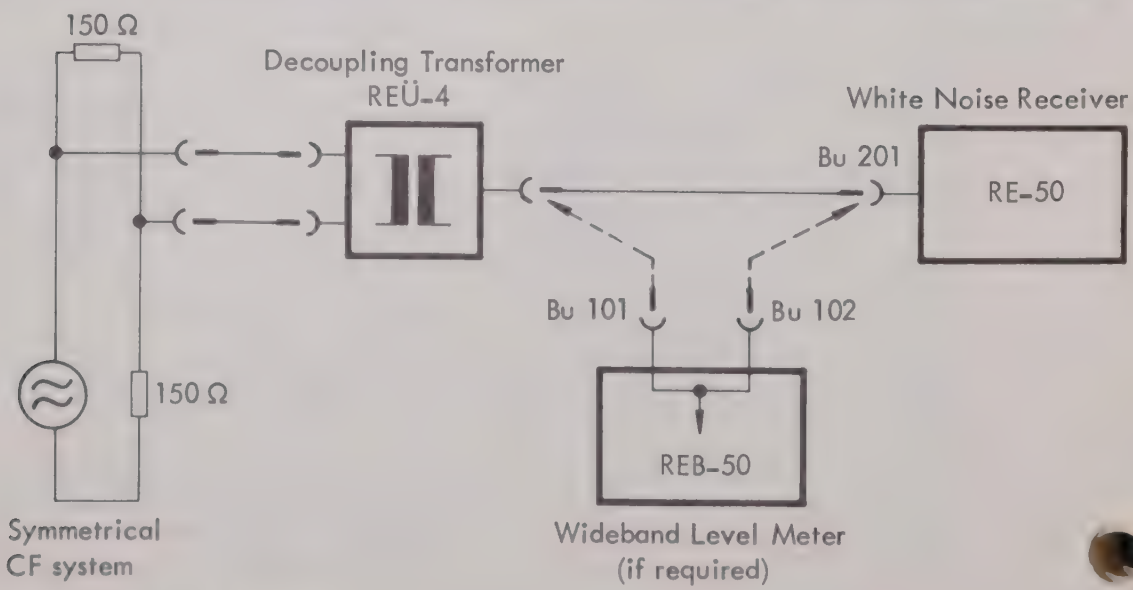


Fig. 2-17 High impedance measurements on symmetrical systems

attenuation of the REÜ-4 can be taken into account when setting up the channel level setting. For this - 20 dB should be added to the actual transmission level. With a transmission level of -15 dBr the transmission level setting of -35 dBr should be selected when taking the decoupling attenuation into account.

The measuring configuration when using the Decoupling Transformer REÜ-4 is shown in Fig. 2-17.

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